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THE

ELEMENTS

OF

MATERIA MEDICA

AND

THERAPEUTICS.

BOSTON ATHENÆUM

BY

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TO

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AND

LECTURER ON THE THEORY AND PRACTICE OF MEDICINE,

ETC. ETC. ETC.

This Work is Dedicated,

AS A TESTIMONY OF HIGH RESPECT FOR HIS GREAT PROFESSIONAL TALENTS

AND ESTEEM FOR HIS PRIVATE WORTH,

BY HIS FAITHFUL FRIEND,

AND GRATEFUL PUPIL,

THE AUTHOR.

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PREFACE

TO THE FIRST EDITION.

THE object of the Author, in preparing the present work for the press, has been to supply the Medical Student with a class book on Materia Medica, containing a faithful outline of this department of Medicine, and embracing a concise account of the most important modern discoveries in Natural History, Chemistry, Physiology, and Therapeutics, in so far as they pertain to Pharmacology. These subjects he has treated of in the order of their natural-historical relations. This method he has followed for many years past in his Lectures, believing it to be the most convenient and, on the whole, the least objectionable mode of classifying the objects of Pharmacology: and he is glad to find that some of the most eminent professors (among whom he may mention his friends Drs. Christison and Royle), follow a similar order in their lectures. Hitherto, however, no systematic work has been published in the English language in which this order has been adopted[a].

It must be admitted, that, as the ultimate object of all our inquiries into the Materia Medica is the attainment of a knowledge of the physiological effects and therapeutical uses of medicines, an arrangement founded on the effects and uses would be much more valuable to the medical student than one based on properties only indirectly related to those for which the agents possessing them are employed. For it would enable him more readily to practise on general indications, and to substitute one remedy for another, belonging to the same class or order. Under this point of view, the author is fully impressed with the value of a physiological or therapeutical arrangement of medicines, and, could it be effected, would readily acknowledge its vast superiority, considered in a medical point of view, over all other classifications: but he is of opinion that Pharmacologists are too imperfectly acquainted with the operation of Therapeutical agents to enable them to effect a classification of this kind with much success. Scarcely two medicines give rise to precisely the same effects: and, as we are unable to determine the nature of the modification produced by each, "it is impossible to bring the substances used in medicine under a general good arrangement[b]." Every writer, who has attempted it, has found the facts hitherto ascertained insufficient for his purpose, and has, therefore, been necessarily obliged to call in the aid of theory: hence the so-called physiological classifications of medicines are in reality founded on the prevailing medical doctrines of the day, or on the peculiar notions of the writer.

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[a] The *Therapeutic Arrangement and Syllabus of Materia Medica*, by J. Johnston, M.D., can hardly be regarded as constituting an exception to this statement.

Opium and mercury may be referred to in illustration of the author's meaning. They are substances in ordinary use, and their effects are well known. Yet writers are neither agreed as to the nature of the primary influence which these agents exercise over the animal economy, nor as to their proper position in a physiological classification.

Thus several physicians (as Dr. John Murray[c] and Dr. A T. Thomson[d]) consider opium to be primarily stimulant; some (as Dr. Cullen[e] and Barbier[f]) regard it as a sedative; one (Mayer[g]) as both—viz., a stimulant to the nerves and circulatory system, but a sedative to the muscles and digestive organs; another (Orfila[h]) as neither; while others (as Müller[i]) call it alterative.

---

[b] *Elements of Physiology.* By J. Müller, M.D.; translated by W. Baly, i. 57.

[c] *A System of Materia Medica and Pharmacy.* 5th ed. 1828. Edinburgh.

[d] *Elements of Materia Medica and Therapeutics.* 2 vols. London. 1832.

[e] *Treatise of the Materia Medica.* 2 vols. Edinburgh. 1787.

[f] *Traité Elémentaire de Matière Médicale.* 2de éd. Paris. 1824.

[g] Quoted by Orfila (*Toxicologie Générale*).

[h] *Toxicologie Générale.* 3me éd. 1827. 2 tom. Paris.

[i] *Op. cit.*

Again, mercury is by several writers (as Drs. Cullen [k], Chapman [l], Young [m], and Eberle [n]) placed in the class of sialogogues; by many (as Dr. A. T. Thomson [o], MM. Edwards and Vavasseur [p], and MM. Trousseau and Pidoux [q]) among excitants; by some (as Conradi, Bertele, and Horn [r]) it is considered to be sedative; by one (Dr. Wilson Philip [s]) to be stimulant in small doses, and sedative in large ones; by some (as Dr. John Murray [t]) it is placed among tonics; by another (Vogt [u]) among the *resolventia alterantia;* by one (Sundelin [x]) among the liquefacients (*verflüssigende Mittel*); by the followers of Broussais (as Begin [y]) among revulsives; by the Italians (as Giacomini [z]) among contra-stimulants or hyposthenics; by others (as Barbier [aa]) among the *incertæ sedis!!*

The author is fully aware of the objections which some will be disposed to raise to the natural-historical and chemical details contained in this work. But with due deference to the opinion of others, he thinks the absence of these subjects would render the present volumes incomplete. A knowledge of them, it is true, is not essential to the successful practice of our profession; but surely a physician will not make a worse practitioner because he is acquainted with the natural history and chemistry of the agents he is employing in the treatment of disease. The author is not ambitious to raise into unnecessary importance these topics; yet he cannot help expressing his belief, that they, who are the loudest in decrying the value and utility of natural history and chemistry to the medical practitioner, are those, for the most part, whose information on these points is most limited.

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[k] *Op. cit.*

[l] *Elements of Materia Medica and Therapeutics.* 2 vols. 4th ed. Philadelphia. 1825.

[m] *An Introduction to Medical Literature;* art. *Pharmacology.* 2d ed. London. 1823.

[n] *Treatise on Materia Medica and Therapeutics.* 2 vols. 2d ed. Philadelphia. 1825.

[o] *Op. cit.*

[p] *Manuel de Matière Médicale.* Paris. 1831.

[q] *Traité de Thérapeutique*, tom. i. Paris. 1836.

[r] Quoted by Richter (*Ausführliche Arzneimittellehre*, Bd. v. 307. 1830).

[s] *On the Influence of Minute Doses of Mercury.* London. 1834.

[t] *Op. cit.*

[u] *Lehrbuch der Pharmakodynamik.* 2 Bd. 2te Aufl. Giessen. 1828.

[x] *Handbuch der speciellen Heilmittellehre.* 3te Aufl. Berlin. 1833.

[y] *Traité de Thérapeutique.* Paris. 1825.

[z] *Trattato filosofico-sperimentale dei Soccorsi Terapeutici.* Padova. 1833.

[aa] *Op. cit.*

In drawing up the Historical and Bibliographical Table, the author thinks it but justice to acknowledge the assistance he has received :—In the Hindoo Department, from his friend, Professor Royle ; in Scandinavian Pharmacological Literature, from Dr. Holst, Professor in the University of Christiana ; in the American department, from Dr. Wood, Professor of Materia Medica and Pharmacy in the University of Pennsylvania,—to all of whom his best thanks are justly due.

London,
Nov. 1838.

PREFACE

TO THE SECOND EDITION.

ENCOURAGED by the rapid sale of a large impression of the first edition of this work, the author has endeavoured to make the present edition still more deserving the favour of the profession, by various additions, alterations, and omissions.

Among the additions will be found articles on *Mental Impressions*, *Light*, *Heat*, *Cold*, *Electricity*, *Magnetism*, *Diet*, *Climate*, and *Exercise,* considered as therapeutic agents. The processes of the British Pharmacopœias (including those of the new Edinburgh one) have been described in a more detailed manner. Upwards of a hundred woodcuts have been added. They comprise figures of crystals, and of some insects used in medicine; microscopic views of the amylaceous grains of commerce; and illustrations of chemical manufactures, and of the modes of preparing some vegetable products. The text has been disencumbered of the references, which have been thrown into the form of foot-notes—and, in the typographical part, various improvements have also been effected.

As some reviewers have spoken in terms of commendation of the very extended index, the author thinks it but just to state that it was carefully made by his wife, to whose pencil he is indebted for the figures of the grains of fecula, drawn to one scale, by an excellent microscope, and camera lucida, lent him for that purpose by his friend and colleague Mr. LUKE.

47, FINSBURY SQUARE,
March 17, 1842.

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CORRIGENDA ET ERRATA.

The reader is requested to correct with the pen the following typographical errors :—

Page, line.
55, 11, *for* gluten, *read* glutin.
55, 14, *for* gluten, *read* glutin.
121, last line but one, *for* minutes, *read* seconds.
125, 26, *for* direct, *read* indirect.
156, 14, *for* This history, *read* The history.
162, last line but two, *for* class, *read* system.
201, after line 22, *insert* ORDER 8. ALKALINE DIURETICS.
218. 10, *transpose* ʒiij. *and* ℥ij.
276. last line but three, *insert before the word chlorine*, those of.
308, last line but 11, *for* SESQUICARBO'NAS, *read* SESQUICAR'BONAS.

Page, line.
328, line 18, *for* hue, *read* trace.
450, line 23, *for* two-thirds, *read* $\frac{6}{8}$.
498, line 8, *for* bicarbonate, *read* bichromate.
595, 35, *for* durus, *read* dura.
598, last line but 4, *for* common, *read* cinnamon.
623, 2, *for* Mundie, *read* Mundic.
657, the right-hand bracket in the diagram should include only the three lower lines of the diagram, instead of seven.
663, last line but 3, *for* inclusive, *read* inconclusive.

Tabular View

OF

THE HISTORY AND LITERATURE

OF THE

MATERIA MEDICA.

1. WORKS ON THE HISTORY OF MEDICINE GENERALLY.

Le Clerc (Dr. D.). *Histoire de la Médecine.* Gen. 1696. 4to; Amst. 1723. 4to; à la Haye, 1729. (Brought down to the time of Galen. An English translation, by Drs. Drake and Baden, 8vo. Lond. 1699).

Freind (Dr. J.). *The History of Physick from the time of Galen to the beginning of the Sixteenth Century.* 2 vols. 8vo. Lond. 3d ed. 1727.

Schulze (Dr. J. H.). *Historia Medicinæ a rerum initio ad annum urbis Romæ* DXXXV. *deducta.* Lips. 4to. 1728.

Ackermann (Dr. J. C. G.). *Institutiones Historiæ Medicinæ.* 8vo. Norimb. 1792.

Sprengel (Kurt). *Versuch einer pragmatischen Geschichte der Arzneikunde.* 3tte Aufl. 5 in 6 Thle. 8vo. Halle, 1821-28. (There is a French translation in 9 vols. by A. J. L. Jourdan, of the 2nd ed. 8vo. 1815-20.)

Choulant (Dr. D. L.). *Tafeln zur Geschichte der Medicin nach der Ordnung ihrer Doctrinen.* Leipzig, 1822. fol.

Augustin (F. L.). *Vollständige Uebersicht der Geschichte der Medecin in tabellarischer Form.* 2te verbess. Ausg. 4to. Berlin, 1825.

Hamilton (Wm.). *The History of Medicine, Surgery, and Anatomy, from the Creation of the World to the commencement of the Nineteenth Century.* 2 vols. small 8vo. Lond. 1831.

Bostock (Dr. J.). *History of Medicine*, in the *Cyclopæd. of Pract. Med.* Vol. 1.

Broussais (Dr. C.). *Atlas Historique et Bibliographique de la Médecine, ou Histoire de la Médecine.* Paris, 1834. (A translation of Choulant's Tables, with some additions.)

2. WORKS CONTAINING A SPECIAL HISTORY OF PHARMACOLOGY.

Cullen (Dr. Wm.). *Treatise of the Materia Medica.* 2 vols. 4to. 1789.

Burdach (Dr. K. F.). *System der Arzneymittellehre.* 3 vols. 8vo. 1807—9.

VOIGTEL (Dr. F. G.). *Vollständiges System der Arzneimittellehre.* 2 vols. 8vo. 1816—17.

CHOULANT. Op. supra cit.

BISCHOFF (Dr. C. H. E.). *Die Lehre von den chemischen Heilmitteln oder Handbuch der Arzneimittellehre.* 3 vols. 8vo. Bonn, 1825—31.

BROUSSAIS (Dr. C.). Op. supra cit. (Choulant's Table in French, without additions.)

3. CATALOGUES OF PHARMACOLOGICAL WORKS.

BALDINGER (E. G.). *Litteratura Universa Materiæ Medicæ, Alimentariæ, Toxicologiæ, Pharmaciæ et Therapiæ generalis medicæ atque chirurgicæ potissimum Academica.* 8vo. Marb. 1793.

BURDACH (K. F.) *Die Literatur der Heilwissenchaft.* 3 B^{de}. 8vo. Gotha, 1810-21. (The 2d volume contains the Materia Medica).

REUSS (J. D.) *Repertorium Commentationum à Societatibus Litterariis editarum secundum disciplinarum ordinem digestum.* Vol. X. ad XVI. *ad Anatomiam, Artem Medicam chirurgicam et Obstetriciam.* 4to. Gotting. 1813—21. (The eleventh volume A. D. 1819, contains the Materia Medica and Pharmacy.)

ERSCH (J. S.). *Handbuch der Deutschen Literatur seit der Mitte des achtzehnten Jahrhunderts bis auf die neueste Zeit, systematisch bearbeitet und mit den nöthigen Registern versehen. Neue Ausgabe.* 3^{tter} *Band enthaltend I. Medicin. II. Naturkunde.* Leipzig, 1822.

YOUNG (Dr. T.). *An Introduction to Medical Literature,* &c. 1813. 2nd ed. 8vo. Lond. 1823.

WATT (Dr. Robt.). *Bibliotheca Britannica, or a general introduction to British and Foreign Literature.* 2 pts. authors and subjects. 4 vols. 4to. Edinb. 1824. (See vol. iv.; subjects *Medica, Materia; Medicines; Pharmacopœia,* and *Pharmacy*).

SPRENGEL (C.). *Literatura Medica externa recentior seu enumeratio librorum plerorumque et commentariorum singularium, ad doctrinas medicas facientium, qui extra Germaniam ab anno inde* 1750 *impressi sunt.* Lipsiæ, 1829.

ROY (C. H.). *Catalogus Bibliothecæ Medicæ,* t. vi. Amstel. 1830. (The 2nd volume contains the "Materies Medica.")

ENSLIN (F. C. F.). *Bibliotheca Medico-Chirurgica et Pharmaceutico-chemica.* 5te Auflage. Leipzig, 1838.

☞ See also PLOUCQUET, "Literatura Medica digesta," 4 vols. 4to. Tubingæ, 1808-9; and "Continuatio et Supplementum I." Tubingæ, 1813. [vol. 3, art. "Medicamenta," and "Medicina, subd. Literatura"];—BERNSTEIN, "Medicinisch-chirurgische Bibliothek," Frankf. 1839 [Art. "Materia Chirurgica," p. 333];—VOIGTEL, op. supra cit.; BUCHNER, "Einleitung in die Pharmacie," Nürnb. 4827; SCHWARTZE, "Pharmakologische Tabellen," Leipzig, 1833; DIERBACH, "Die neuesten Entdeckungen in der Materia Medica," Bd. 1, Heidb. 1837; and BAILLIERE'S "Catalogue des Livres," 1840.

B.C.	EGYPTIAN MEDICINE.
	THOUT or THAUT (also called Hermes or Mercury) regarded as the founder of Medicine.
	Medicine practised first by priests, afterwards by physicians who confined themselves to the study of one disease. (Herod. *Euterpe* LXXXIV.)
	The sick exposed in public places (*Strabo*).
	Purges, vomits, and clysters, used for three days successively in every month. (Ibid. LXXVII.). Abstinence; dietetical regulations: the hog regarded as unclean. Baths and unguents.
	Worshipped a bulbous plant (Κρόμμυον; *Squilla?*) to which they erected a temple Pauw).
	Employed *aëtites,* slime of the Nile, frictions with crocodile's fat in rheumatism, and mucilage of *semina psyllii.* Salt, νίτρον (carbonate of soda?), alum, plasters, and unguents; white lead and verdigris occasionally entered into the latter.
	Fumigations with *Cyphi* (Κῦφι) a mixture of various drugs. (Dioscorides, i. 24.)
1729	Spices, balm, and myrrh, carried to Egypt, and doubtless used by the Egyptians. (*Gen.* XXXVII. 25.)

B.C.

EGYPTIAN MEDICINE.—*Continued.*

1680 Embalming practised. Palm wine, aromatics, myrrh, cassia, and other odorous substances (not frankincense), as well as *νίτρον* (carb. soda?) and gum used in this process. (Herod. *Euterpe*, LXXXVI.)

Alexandrian School [see Greek Medicine].

☞ Consult,—PAUW (M. De), "Phil. Dissert. on the Egyptians and Chinese," vol. 1, p. 130. 1795. ALPINUS (Prosper), "De Medic. Ægypt." Lugd. 1745. Also CLOT-BEY, "Aperçu Général sur l'Egypt." 2 vols. 8vo. Paris, 1840.

B.C.

HEBREW MEDICINE.

The infliction and cure of diseases on various occasions ascribed by the Sacred Historian to the direct interposition of God. (*Exod.* ix. 15. *Numb.* xii. 10.)

Remedial agents consisted principally in strict hygienic means. (Circumcision, dietetical rules, separation, ablution, combustion of infected garments. (See *Gen.* xvii. 10; *Lev.* xi. & xiii.; 2 *Kings*, v.)

1491 Medicine practised by the Priests. (*Lev.* xiv.) Gold, silver, lead, tin, iron, and brass (copper?) mentioned by Moses.

1491 Odoriferous ointment and confection; the most ancient recipes on record. (*Exod.* xxx. 23—25, & 34—35.)

"There are named in the Pentateuch about 20 minerals, 10 vegetables and animals" (Alston).

1063 Music employed as a remedy. (2 *Sam.* xvi. 16)

884 Sesquisulphuret of antimony used as a face paint. (2 *Kings*, ix. 30.)

713 Fig poultice. (2 *Kings*, xx. 7.)

600 Physicians (not priests) referred to. (*Jerem.* viii. 22.) N. B. The so-called Egyptian physicians (*Genes.* l. 2.) were probably *ἐνταφιασταί*, undertakers, or embalmers.

The following substances are referred to in the Bible: the Olive, Saffron, Barley, Wheat, the Fig, the Vine, Myrrh, Bdellium, Galbanum, Cumin, Coriander, Flax, Garlic, Balm of Gilead, Olibanum (Frankincense), Cassia, Cinnamon, the Almond, the Pomegranate, Dill (in our translation incorrectly called Anise)—Colocynth? Ricinus?

A. D.

40 Herod was let down into a bath of oil. (Josephus, *Bell. Jud.* lib. I. cap. 33. § 5.)

Oil and wine applied to wounds. (*Luke*, x. 34.)

Various superstitious practices. (Adam Clarke *Comm.* Note to Mark, v. 26.)

☞ For further information respecting Hebrew medicine consult the "Bible";—J. H. HORNE'S "Introd. to the Crit. Study and Knowl. of the Holy Script. vol. iii. 8th ed. 1839:—LAUTENSCHLAGER, "Dissert. de medicis veterum Hebræorum, eorumque methodo sanandi," Strasburg, 1786;—K. SPRENGEL, "Analecta Historica ad Medicinam Ebræorum," Hal. 1796.—D. CARCASSONE, "Essai Historique sur la Med. des Hebreux, anciens et modernes." 8vo. Montp. 18.5.—A "Flora Biblica" is contained in SPRENGEL'S Historia Rei Herbariæ," t. i. Amstel. 1807.

B. C.

ASSYRIANS.

The Babylonians had no professors of medicine. They exposed their sick in public places, in order that passengers might communicate their experience as to the best mode of cure (Herodotus, *Clio* cxcvii.). Extracted oil from the Sesamum. (Ibid. cxviii).

☞ Consult,—SMOLL (D. G.), "Venerandæ antiquitatis Assyriorum Chaldæorum, &c. Philosophorum Medicorum Regum et Principum philosophica et med. Principia." 4to. Lubec. 1609.

A.D.

CHINESE MEDICINE.

229 Of its ancient state but little is known. The Chinese pretend that its study was coeval with the foundation of their empire, and that their medical code was the production of Hoangti, B. C. 2000. (Grosier.) Before the Christian era there was a constant communication between China and India. (*Asiat. Journ.* July, 1836.)

Medical science commenced with Chang-ka; for all works before that (said to be dated B.C. 1105 & 189) treat of medicine, without giving prescriptions. (*Trans. of Med. Soc. of Calc.* i. 146.) As the Chinese have retained their ancient manners and customs, we must judge of what their medicine was by what it is.

Pun-tsaou (or *Herbal*), the most considerable Chinese work on Materia Medica, includes minerals, vegetables, and animals. Davies, ii. 278.) [A copy in the British Museum.]

Ching che chun ching (*Approved marked line of Medical Practice,*) a celebrated work in 40 vols.; of which, eight are devoted to *Luy-fang* (*Pharmacology*). The articles of the Materia Medica are very numerous. Ginseng is their panacea. Aromatics and gums in apoplectic cases. Opium as an anodyne and in dysentery. Mercury both raw and oxidized. Musk, rhubarb, tea, camphor of the Dryobalanops, asafœtida, spices,

A.D.

CHINESE MEDICINE.—*Continued.*

larvæ of the silk worm, bones of tigers and elephants, vegetable wax, horns, fins, &c. Moxa. Croton Tiglium.

☞ Consult,—Du Halde (J. B.), "Descript. Geogr. et Hist. de la China," t. 3. p. 318. 1770; Grosier (L'Abbe), "Descript. Gén. de la China," t. ii. p. 466. 1817; Davies (F. J.), "The Chinese," vol. 2, p. 278; Gutzlaff, "Journ. of the Asiat. Soc." vol. iv. p. 154.

B.C.

HINDOO MEDICINE.

1. *Ancient Medical Authorities and their Works.*

Brahma the Hindoo Deity; author of the *Vedas*, the most ancient books of the Hindoos, and next in antiquity to those of Moses. (Sir W. Jones, *Disc.* ix.)

Ayur Veda, the oldest medical writing of the Hindoos, forms a part of the 4th or *Atharva Veda* (the least ancient Veda). It is distributed into eight subdivisions. (See H. H. Wilson, *Calcutta Orient. Mag.* Feb. and March 1823; and Royle, *Essay*, p. 57.)

Dachsa, the *Prajapati*, to whom Brahma communicated the Ayur Veda, instructed the two Aswins or Sons of Surya (the Surgical attendants of the gods).

A.D.

Date uncertain.—Cannot be later than the Ninth or Tenth Century, A.D. and probably much more ancient.

According to some the Aswins instructed Indra the preceptor of Dhanwantari (also styled *Kasiraja*, prince of Benares); but others make Atreya, Bharadwaja, and Charaka, prior to the latter.

Charaka (*Sarac*, *Scarac*, *Scirak* or *Xarac*) mentioned by Serapion, Avicenna, and Rhazes. His work is extant, but not translated.

Susruta, son of Viswamitra, was pupil of Dhanwantari and contemporary of Rama. Treats chiefly of *Salya* and *Salekya* or Surgery, and divides medicines into locomotive (animals both viviparous and oviparous, and produced in moist places) and non-locomotive (plants and minerals). Gold, Silver, Arsenic, Mercury, Diamonds, Earths, and Pearls, are enumerated; also Heat and Cold, Light and Darkness, the increase and decrease of the Moon's age, as remedial means. Lithotomy, the Extraction of the Fœtus, Venesection. 127 weapons and instruments. Actual cautery. Alkaline caustics. Heated metallic plates. Leeches. Gourds used as cupping glasses. Astringent and emollient applications. Leaves, pledgets, threads, and bandages. Drastic and mild purgatives, emetics, diaphoretics, baths, and aspersions of water, Stimulants, Sedatives, Narcotics, and Acrid poisons all employed. Datura, Nux Vomica, Croton Tiglium, Myrobalans, &c. were adopted by the Arabs.

☞ Susruta (The ; or System of Med. taught by Dhanwantari and composed by his disciple Susruta Vol. i. 8vo. Calc. 1835.—For a list of Sanscrit medical and other works, see Ainslie, "Mat. Med." vol. ii. p. 491.

B.C.

2. *Early Translations from Hindoo Works.*

α. *Tamul*, by Maha Rishi Aghastier, who is named, in the *Ramayana*, the oldest Hindoo profane work, and which is supposed to have been revised by the poet Calidas in the reign of Vikramaditya, whose era commences B.C. 57. (For a classification of drugs in a Tamul work called the *Kalpastanum*, see Royle's *Essay*, p. 54.)

β *Cingalese.* (See a list in Ainslie's *Mat. Ind.* vol. ii. p. 525; also Heyne's *Tracts on India*, p. 125—171.)

γ. *Tibetan* made in the eighth century. (See Csoma de Körös, in *Journ. Asiat. Soc.* iv. 1.) 715 substances are mentioned, most of which are indigenous in India.

3. *Antiquity of Hindoo Medicine.*

Cannot be determined by Hindoo chronology or authors: hence must be ascertained from other sources. The great antiquity of Hindoo Medicine is proved by the following circumstances:

α. *Indian products are mentioned in the Bible.* (Royle, p. 138.) In early times commerce was established between India and Persia, Syria, and Babylon; also, by the Persian and Arabian Gulphs, with Egypt, &c.

β. *At a very early period India was peopled and in a high state of civilization.* (For proofs, see Royle, p. 150 to 179.) As many chemical arts (e. g. distillation, bleaching, dyeing, calico printing, tanning, soap and glass making, manufacture of sugar and indigo) were practised by the Hindoos, who were acquainted with, and their country contains, all the chemical substances mentioned by Geber, it is not improbable that they, and not the Arabs, originated Chemistry. The Grecian sages travelled in the East: hence the coincidences between the systems and discoveries of the Greeks and those recorded in Sanscrit works.

γ *Indian products are mentioned by the Greeks and Romans* (e. g. by Hippocrates, Theophrastus, Dioscorides, Pliny, Oribasius, Ætius, and Paulus). They were doubtless employed in the countries where they were indigenous before they were exported.

B. C.

HINDOO MEDICINE.—*Continued.*

δ. *Ancient Inscriptions shew the Antiquity of Hindoo Medicine.* A medical edict by King Piyadasi, directing the establishment of depôts of medicine, and the planting of medicinal roots and herbs throughout his dominions and in the countries where Antiochus and his generals commanded. This, therefore, must have been issued and cut in rocks and metal pillars as early as B. C. 220.

A. D.

ε. *The Persians translated Hindoo Works* A.D. 531 to 579. (Royle's *Essay*, p. 68.)

ζ. *Hindoo physicians were in high repute at the Court of Harum Al-Rashid and Al-Mamoon, from* A.D. 786 to 850.

η. *The Arabian authors* (Rhazes, Serapion, Mesue, and Avicenna) *mention Charak, and quote from the Susruta.*

☞ Consult,—WILSON (H. H.), "Orient. Mag." Calc. 1823; and "Trans. Med. and Phys. Soc." Calc. vol. I.; HEYNE (B.), "Tracts on India," Lond. 1814; AINSLIE (W.), "Mat. Ind." 2nd vol. Lond. 1826; DIETZ (F. R.), "Analecta Med." Lips. 1834; ROYLE (J. F.), "Essay on the Antiq. of Hindoo Med." 1837; GELDEMEISTER, "Scriptorum Arabum de rebus indicis loci et opuscula inedita." 8vo. Bonn, 1838.

Taleef Shereef, or *Indian Materia Medica.* 8vo. Calc. Eng. trans. by G. Playfair, 1833.

A. D.

4. *English Writers on Indian Materia Medica.*

1810 FLEMING (Dr.). *Catalogue of Indian Medicinal Plants and Drugs* in the Asiatic Researches. Vol. xi.

1813—26 AINSLIE (Dr. W.). *Materia Medica of Hindostan.* 4to. 1813.—*Materia Indica.* 2 vols. 8vo. 1826.

1832 ROYLE (J. F.). *List of Articles of Materia Medica obtained in the Bazars of the Western and Northern Provinces of India.* In the *Journal of the Asiatic Society of Bengal.* 1 vol. 1832.

1841 O'SHAUGHNESSY (W. B.). *The Bengal Dispensatory and Pharmacopœia. Chiefly compiled from the Works of Roxburgh, Wallich, Ainslie, Wight and Arnott, Royle, Pereira, Richard and Fée, and including the results of numerous special experiments.* Published by order of Government. Calcutta. [Three parts, including pp. 622, have appeared.]

☞ Much valuable information on Indian Materia Medica is contained in ROYLE'S "Illlustrations of the Botany and other branches of the Natural History of the Himalayan Mountains," 4to. 1824—41. Several interesting papers on the same subjects have appeared in the Anglo-Indian Journals. See also the works of HEYNE, BUCHANAN (HAMILTON), and CRAWFORD.

B. C.

GREEK MEDICINE.

1. *Before the time of Hippocrates.*

1398 MELAMPUS, a soothsayer and physician. Cured impotence by iron wine (Apollod. *Bibl.* Fr. transl. lib. i. cap. ix. p. 75); and madness by hellebore (Pliny, xxv. 21).

1270 CHIRON, *a Centaur*, a physician and surgeon. Was cured of a wound by the *Centaurea Centaurium* (Ibid. xxv. 30). Had several pupils, as Hercules (to whom the invention of the warm bath is ascribed) and Æsculapius.

1263 ÆSCULAPIUS or ASCLEPIAS, renowned for his medical and surgical skill. Employed amulets, incantations, charms, potions, incisions, and topical remedies (Le Clerc). His sons MACHAON and PODALIRIUS also famous surgeons; the latter practised venesection.

1184 Destruction of Troy.

1134 The first temple to Æsculapius founded.

968 } EUROPHON, author of the Γνῶμαι Κνιδιαι or Cnidian Sentences.

907 } HOMER mentions the Papaver somniferum, sulphur fumigations, νηπενθές (*Cannabis indica?* opium ??), Moly (?), &c.

884 }

617 ARISTÆUS discovered Silphium (see p. 1453).

580—500 PYTHAGORAS employed Magic, Dietetics, Mustard, Anise, and Vinegar of Squills (Pliny xix. 30).

ASCLEPIADEÆ.

Descendants and followers of Æsculapius and priests of his temples. Extended over 700 years, i. e. until Hippocrates. The temples became schools of medicine, the most celebrated of which were the Coan and the Gnidian. The priests of the former attempted to unite reasoning with experience; those of the latter attached themselves to observations and matters of fact. The remedies used were Gnidian berries, juice of euphorbium, hellebore, scammony, colocynth, briony, elaterium, mineral waters, &c. (Le Clerc, Sprengel, Bostock). Votive tablets were erected in the temples.

B.C.	GREEK MEDICINE.—*Continued.*
	2. *Hippocrates.*
460—to 360 ?	HIPPOCRATES the "*Father of Medicine.*" Born at Cos. The 18th by his father from Æsculapius. Ascribes diseases to alterations of the humours (blood, pituita or phlegm, and yellow and black bile). An antipathic. Employed diet, baths, exercise, blood-letting (venesection, cupping, and scarification), the actual cautery, the knife, and a very extensive series of medicines. Alston found in the works which pass under the name of Hippocrates "about 36 mineral, 300 vegetable, and 150 animal substances," and he adds, "I cannot pretend to have overlooked none." The Hippocratean materia medica includes : 1st. *Minerals,*—sulphur, lime, carbonate of soda, alum, common salt, oxide and carbonate of lead, acetate (and sulphate ?) of copper, oxide of iron, and yellow and red sulphuret of arsenicum. 2ndly. *Vegetables,*—acacia, allium, ammoniacum, anethum, anisum, cardamomum, cassia, cinnamon, colocynth, conium, coriandrum, crocus, cuminum, cydonia, elaterium(?), euphorbia, fœniculum, galbanum, gallæ, glycyrrhiza, gnidium, helleborus, hyoscyamus, juniper, lactuca, laurus, linum, malva, marrubium, mastic, mentha, morus, myrrha, olea, opium, opobalsamum, opoponax, origanum, piper, pix, pulegium, punica, quercus, rosa, rubia, rumex, ruta, sambucus, sagapenum, scammonia, scilla, silphium, sinapis, staphisagria, styrax, turpentine, and veratrum. 3rdly. *Animals,*—*κανθαρὶς* (Mylabris Füsselini ?), castoreum, sepia, ova, cornua, mel, serum lactis, and cera. ☞ DIERBACH (Dr. J. H.), "Die Arzneimittel. des Hippokrates." Heidelb. 1824.
	3. *From Hippocrates to Galen.*
380 354 341 336	ANCIENT DOGMATIC (*or Hippocratean*) SCHOOL (*Theory in Medicine*). 380. Founded by THESSALUS and DRACO (Sons of Hippocrates), in conjunction with POLYBIUS (their brother in law).——354. DIOCLES CARYSTIUS (called the second Hippocrates) wrote on plants and dietetics. Gave a leaden bullet in ileus.——341. PRAXAGORAS *of Cos* (the last of the Asclepiadeæ); vegetable medicines.——336. CHRYSIPPUS *of Cnidus,* opposed bleeding and purging, and vegetable medicines.
304 285	*Alexandrian School.*——304. ERASISTRATUS (pupil of Chrysippus) opposed bleeding; used simple medicines.——307. HEROPHILUS *of Chalcedony,* a demi-empiric, used compound and specific medicines.——285. Medicine divided into *Dietetics, Pharmacy,* and *Surgery.*
384—322 371—286	NATURAL HISTORIANS. 384—322. ARISTOTLE; wrote on animals (also on plants and pharmacy). 371—286. THEOPHRASTUS, the founder of botany.
290 240 233 140 135—63 168 138	EMPIRIC SECT (*Experience the sole guide*)—290 founded by PHILINUS *of Cos* (disciple of Herophilus).——240. SERAPION of Alexandria.——230. HERACLIDES of *Tarentum* ("*Prince of Empirics*") used conium, opium, and hyoscyamus, as counter-poisons. NICANDER *of Colophon,* wrote on poisons and antidotes : his Θηριακὰ 'Αλεξιφάρμακα. still extant.——135 to 63. MITHRIDATES; his supposed antidote (*Mithridatium Damocratis*) contained 54 substances.——158. ZOPYRUS employed a general antidote (*Ambrosia*); classified medicines according to their effects. CRATEVAS a botanist.——138. CLEOPHANTUS described medical plants.
160	*Gentian* first used by Gentius, king of Illyria.
100	METHODIC SECT.—100. ASCLEPIADES *of Bithynia* rejected all previous opinions, and termed the Hippocratean system "*a meditation on death.*"——63. THEMISON *of Laodicea,* pupil of Asclepiades, founder of the sect. Explained all physiological and pathological doctrines by the *strictum* and *laxum* of the organic pores, and regarded all medicines as astringents or relaxants. Employed leeches.
A. D. 54 ?	DIOSCORIDES (Pedacius). The most renowned of all the old writers on Materia Medica His work is the best (of the ancient ones) on the subject, and for 1600 years was regarded as the first authority. "In him I counted about 90 minerals, 700 plants, and 168 animal substances, that is 958 in all, without reckoning the different simples the same substance often affords." (Alston, *Lect.* i. 15.) Dr. Sibthorp visited Greece for the purpose of studying on the spot the Greek plants of Dioscorides. (*Flora Græca;* and *Prodr. Fl. Græcæ,* by Sir J. E. Smith.)
131—200	GALEN (Claudius) a brilliant genius of vast erudition and rare talents. Explained the operation of medicines by reference to their elementary qualities (heat, cold, dryness, and moisture), of each of which he admitted four degrees. This doctrine was held in the schools until the time of Paracelsus. Galen gives the names and virtues of 540 plants, 180 animal, and 100 mineral substances. (Alston.)
	4. *From Galen to the fall of the Greek School.*
360	ORIBASIUS. Transcribes and abridges Dioscorides and Galen. Both he and Aëtius were called Simiæ Galeni (Alston).
550	AËTIUS. Employed musk medicinally.
560	ALEXANDER TRALLIANUS. First mentions rhubarb, which he states was used in diseases of the liver and in dysentery. Notices hermodactyl. Used mild laxatives. Is the first who speaks of the use of steel in substance.

A. D.

GREEK MEDICINES—*Continued.*

600 } 700 } PAULUS ÆGINETA. First notices the purgative properties of rhubarb. Distinguishes between *Rha* and *Rheon.* Describes the effects of hermodactyl.

1034 SETH (Simeon). Notices camphor.

(Minor Greek Authors.)

1100 } 1300 } ACTUARIUS (John). Mentions capsicum (κάψικον). The first Greek who mentions the milder purgatives (as cassia, manna, senna, myrobalans).

1300 ? MYREPSUS (Nicholas).

5. *Modern Greek Medicine.*

1837 Ελληνικη Φαρμακοποιΐα. *Pharmacopœa Græca jussu Regio et approbatione Collegii Medici edita auctoribus* Joanne Bairo, Xaverio Landerer, Josepho Sartori. pp. 542, 8vo. Athenis.

ROMANS OR ITALIANS.

A. D.

In the early periods of Roman history medicine was practised by slaves and freedmen.

23 MENECRATES. Employed escharotics. Invented Diachylon plaster.

13—55 CELSUS (A. Cornelius). *De Medicina.* A methodist? An elegant writer. Lays down hygienic rules. Distinguishes foods according to the degree of their nutritive power and digestibility. His remarks on these subjects, as well as on the use of remedial agents generally, display great judgment. Speaks of the use of nourishing clysters, gestation, baths, frictions, &c. Employed in dropsy frictions with oil.

41 SCRIBONIUS LARGUS. An empiric. His work (*Compositiones Medicæ*) is the first pharmacopœia known.

23—79 PLINY the Elder (Caius). A natural historian. In his work (*Historia Naturalis*) he has collected all that was known in his time, of the arts, sciences, natural history, &c. He displays prodigious learning and a vast fund of erudition. In botany and materia medica he has copied almost verbatim the remarks of Theophrastus and Dioscorides.

230 CÆLIUS AURELIANUS. A methodist. The only one of this sect whose works have descended to us.

PERSIAN MEDICINE.

B. C.

1491 Must be very ancient, but its history scarcely known. Products of Persia (ex. galbanum, asafœtida, sagapenum, &c.) mentioned in the Bible or by Hippocrates: it is to be presumed that the Persians knew the medical qualities of their indigenous drugs, previous to selling them.

400 Ctesias of Cnidus, physician for seventeen years to Artaxerxes Mnemon.

A. D.

272 Dschondisabour (Jondisabur of Nisabur) founded. Greek physicians sent by the Emperor Aurelian.

ALMANZOR, the second Caliph of the house of Abbas, a great encourager of the sciences and medicine.

1055 ABU MANSUR MOWAFIK. *Liber fundam. Pharmacol.* Lat. trans. by R. Seligmann Vindob. 1830—33.

1392 *Ikhtariat Buddee.* Said by Toohftul Moomineen to be the first work, in the order of time, written on medicines in the Persian language (Royle, p. 27).

Phamacopœa Persica, ex idiomate Persico in Latinum conversa. Paris, 1681.

1528 SHIRAZY (Nouraddeen Mohammed Abdullah). *Ulfáz Udwiyeh, or the Mat. Med. in the Arab. Pers. and Hindevy lang.* Eng. transl. by F. Gladwin. Calc. 1793.

1669 MEER MOHUMMUD MOOMIN. *Toohft al Moomineen.* The most esteemed of the Persian works. The author states that he is the third, in the order of time, who had written on medicines in the Persian languages. (Royle, p. 26.)

1769 *Mukhzun al Udwick* or *Storehouse of Medicines.* Hoogly. 1824. 2 vols. small fol. (Royle, p. 26.)

☞ See also GLADWIN'S "Compendious Vocabulary, English and Persian, including all the Simples in the Materia Medica employed in Modern Practice," 4to. Malda 1780; Dr. R. SELIGMANN, "Ueber drey höchtseltene Persische Handschriften. Ein Beytrag zur Literatur der Orientalischen Arzneymittellehre," Wien, 1833; ROYLE, op. supra cit. p. 26, and the list of Persian and Arabic Medical and Scientific Books in AINSLIE'S "Mat. Ind." vol. ii. p. 504.

⁂ Dr. Royle has suggested to me the propriety of making a distinction between the Materia Medica of the Persians previous and subsequent to that of the Arabs. But convenience and limited space have prevented me from adopting his suggestion.

ARABIANS.

A. D.	
767	Bagdad built. The sciences munificently patronised by the Caliphs. A college formed. Hospitals and dispensaries established.
	Schools of Damascus and Cordova.
	The doctrines of Hippocrates and Galen taught. Mild laxatives (as cassia, tamarinds, manna, rhubarb, and senna) substituted for drastics. Chemical medicines mentioned Various pharmaceutical preparations (syrups, juleps, conserves, loochs, robs, and distilled waters and oils) contrived. Dispensatories published.
622	Aaron or Ahron (*The Pandects*).
Died 872	Ebn-Sahel (Sabor) *Krabadin*, the first Dispensatory.
Died 880	Alkhende (J.). Wrote on the proportions and doses of medicines.
Born 702	Geber, *The Patriarch of Chemistry.* Mentions nitric acid, vinegar, aqua regia, chloride of sodium, carbonates of potash and soda, caustic soda, nitrate of potash, sal ammoniac, alum, sulphate of iron, borax, nitrate of silver, bichloride and binoxide of mercury, cinnabar, litharge, and red lead. May have obtained his knowledge from the Hindoos. (See *Hindoo Medicine.*)
Died 846 865	Mesue (John). *De simplicibus et de electuariis.*
900 742 1066	Serapion (John, jun.). *De simplicibus medicinis.*
	Abn Guefith or Abhen Gnefith. *De simplic. medicam. virtut.*
852 to 932	Rhazes. *De simplicibus medicinis.* One of the most celebrated Arabians. Employed mercurial ointment.
978 to 1035	Ebnsina or Avicenna, "The Prince of Physicians." His *Canon medicinæ* is a compilation from Galen, Aëtius, and Rhazes : for five centuries it was regarded as an infallible guide. Mentions croton tiglium, camphor, nux vomica, mace, nutmegs, &c.
680	Haly Abbas. (*Amalek or the Royal book*).
1179?	Avenzoar at Seville in Andalusia.
Died 1198 or 1199 1206	Averrhoes, a native of Cordova.
12th or 13th century 1085	Albucasis or Alsaharavius. Mentions the preparation of rose water.
Died 1248	Abn Bitar or Ibn-Beitar. His works have not been printed, but they are constantly quoted by Persian authors on Materia Medica. (Royle, *Essay*, p. 28.) He has a most extensive influence in the East.

☞ Consult,—Amoreux (P. J.), "Essai Historique et Litter. sur la Médec. des Arabes." Montp. 1805. 8vo. Reiske (J. J.), "Opusc. Med. ex Monum. Arabum et Ebræorum." Halæ 1776. 8vo.

⁂ In the "Pharmaceutisches Central-Blatt f. 1839," p. 313, is a notice, by Dr. A. Buchner, of a collection of Arabian medicines made by Dr. Schubert, in Arabia.

EARLY CHRISTIAN WRITERS ON MEDICINE.

(Dark Ages.)

A. D.	
	Medicine practised by Monks. Magic and Astrology employed in medicine. The period of superstition and alchemy. The grossest impositions practised.
	The Neapolitan *Schools of Monte-Cassino* and *Salerno* founded by Benedictine Monks.
Died 1107	Constantine *the African.* Wrote on diet, and simple and eye medicines.
1100	John of Milan. The supposed author of the *Regimen Sanitatis Salernitanum*, a collection of dietetical precepts, in rhyming latin verse, addressed, by the Medical School at Salerno, to Robert, son of William the Conqueror. Above 160 editions of this work have been published—(see Sir Alexander Croke's ed. Oxford, 1830, 8vo.)
1110	Nicholas surnamed Præpositus. *Dispensatorium ad aromatarios;* the first European pharmacopœia.
1150	Matthew Platerius. 1169 Ægidius of Corbeil.
1180	Hildegard, Abbess of Bingen. Born 1098. Wrote on medicines. Mentions *Christiana* (supposed to be *Helleborus niger.*)
1259	Gilbert, an Englishman. Prepared acetate of ammonia and oil of tartar *per deliquium.* Extinguished mercury by saliva.
1193—1282	Albertus magnus. An alchemist. Mentions zinc.
1260	John of St. Amand. Commented on the works of Nicholas.

A.D.	EARLY CHRISTIAN WRITERS ON MEDICINE.—*Continued.*
1214—1284	Roger Bacon, The most philosophical of the Alchemists.
1240—1313	Arnold of Villa Nova. Wrote a commentary on the Regimen Salernitana. Prepared the oils of turpentine and rosemary.
1235—1315	Raymond Lully. Prepared the oil of rosemary, acetate of lead, ammonio-chloride of mercury, nitric oxide of mercury, and spirit of wine.
1295	Simon de Cordo. 1317. Matthew Sylvaticus. 1320. (death) Peter de Apono. 1328. Francis of Piedmont. 1343. Dondis, father and son.
Died 1320	Platerius (John). *Antidotarium Nicolai cum expositione.*
1343	St. Ardouin. Red oxide of mercury.
Born 1394	Basil Valentine. Prepared chemical medicines. Introduced antimonials (*currus triumphalis antimonii*). Was acquainted with the double chloride of iron and ammonia, and the acetates of lead.
1418	Valescus de Tarenta.
1491	*Ortus sanitatis* (first botanical figures).
1492	Columbus discovers America. Tobacco and its use for smoking first known.
1497	Mercury employed externally in syphilis.
1508	Guaiacum introduced into Europe by the Spaniards.
1493—1541	Paracelsus. A vain, ignorant, arrogant, drunken quack, fanatic, and impostor. He burnt publicly the works of Galen and Avicenna, declaring that his shoe-strings possessed more knowledge than those two celebrated physicians, and asserted that he possessed the elixir of life! He was a cabalist, astrologer, and believer in the doctrine of signatures. He conferred several important benefits on medicine: he overturned Galenism, introduced chemical medicines (employed mercury in syphilis), and substituted tinctures, essences, and extracts, for various disgusting preparations. (A more favourable opinion of the character of Paracelsus is entertained by some writers.)
1305	Sarsaparilla first appeared in Europe.
1532 1542	Early *botanists* in whose works several medicinal plants are distinctly referred to, in some cases, for the first time. 1530. Brunfelsius; *Cardamine pratensis; Scrophularia nodosa.* 1532. Tragus; Foxglove (*Campanula sylvestris*); Belladonna (*Solanum hortense nigrum*), Dulcamara. 1542. Fuchsius; Stramonium; Digitalis.

A.D.	GREAT BRITAIN.
1579	Winter's Bark brought to Europe.
1633	Serpentary root noticed by Thomas Johnson.
1674	Willis (Dr. Thos.) *Pharmaceutice Rationalis.* 8vo.
1675	Sulphate of Magnesia obtained from the Epsom Waters by Dr. Grew.
1687	Floyer (Sir J. M. D.). *Φαρμακο-Βασανος: or the Touchstone of Medicines.* 2 vols. 8vo.
1691	Bate (Dr. G.). *Pharmacopœia Bateana*, by Fuller. 12mo.
1693	Dale (Dr. S.). *Pharmacologia*, seu *Manuductio ad Mat. Med.* 8vo. 1693.—3tia ed. 4to. 1737.
1697	Sulphuric acid made from sulphur.
1702	Mead (Dr. Richard). *A Mechanical Account of Poisons.* 5th ed. 1756. 8vo.
1718	Quincy (Dr. J.). *Pharmacopœia officinalis et extemporanea; or, a Complete English Dispensatory.* 14th ed. 1736.
1724	Douglas (James). *Index Materiæ Medicæ, or a Catalogue of simple Medicines.* Lond. 1724. 4to.
1730	Bradley (R.). *A Course of Lectures upon the Materia Medica, Antient and Modern.* 8vo.
1740	Spigelia as an anthelmintic made known.
1742	Senega introduced by Dr. Tennant.
1747	James (Dr. R.). *Pharm. Univ. or a New Engl. Dispens.* 8vo.
1751	Hill (Dr. J.). *A History of the Materia Medica.* 4to.
1753	Brookes (Dr. R.). *The General Dispensatory.* 8vo.
1754	Lewis (Wm.). *The New Dispensatory.* 8vo. Several editions were published during the lifetime of the author.—*The Edinburgh New Dispensatory*, published after his death, was essentially a new edition of his work. It was successively edited by Dr. Webster, Dr. Duncan, Dr. Rotheram, and Dr. Duncan, Jun.
1758	A red astringent gum (Kino?) described by Dr. Fothergill.
1761	Lewis (Wm.). *An Experim. Hist. of the Mat. Med.* 4to.—4th ed. in 2 vols. 8vo. by Dr. Aikin, 1791.
1763	Bark of Salix alba used by Rev. Mr. Stone.
1763	Receipts for preparing Ward's Medicines.
1768	Alexander (Wm.). *Experimental Essays.* 8vo.
1770	Alston (Dr. Ch.). *Lectures on the Materia Medica.* 2 vols. 4to.
1770	Monro (Dr. D.). *Treatise on Mineral Waters.* 8vo. 2 vols.
1733—1804	Priestley (Dr. J.) discovered oxygen, protoxide of nitrogen, and hydrochloric acid, ammoniacal and sulphurous acid gases.
1775	Rutty (Dr. J.). *Materia Medica, Antiqua et Nova.* Rotterod. 1775.
1775	Withering (Dr. Wm.). *Account of the Foxglove.* 8vo. Birm.
1780	Brown (Dr. John). *Elementa Medicinæ.* Regarded all medicines as stimulants, and as differing from each other in little more than the degree in which they exert their stimulant power. (*Brunonian theory.*)
1781	Home (Dr. F.). *Methodus Materiæ Medicæ.* 12mo.

A.D.	GREAT BRITAIN—*Continued.*
1782	Saunders (Dr. W.). *Observations on Red Peruvian Bark.*
1783	Home (Dr. Fr.). *Clin. Experim. Hist. and Dissect.* 8vo.
1785	Aikin (Dr. J.). *A Manual of Materia Medica.* 8vo. Yarmouth.
1786	Duncan (Dr. A.). *Heads of Lectures on the Materia Medica.* 8vo.
1788	Monro (Dr. Donald). *A Treat. on Med. and Pharm. Chym. and the Mat. Med.* 3 vols. 8vo.
1788	Angostura bark imported into England.
1789	Cullen (Dr. Wm.). *A Treatise of the Materia Medica.* Regarded all medicines as acting by motions excited in, and propagated by, the nervous system.
1790—94	Woodville (Dr. W.). *Medical Botany.*—4 vols. 4to. 2d ed. 1810.—3d ed. in 5 vols. by Hooker and Spratt, 1832.
1792	Moore (J.) *Essay on the Materia Medica.* 8vo.
1793	Alderson (Dr. J.). *Essay on Rhus Toxicodendron.* 8vo.
1794-5	Beddoes (Dr. Thos.) and Watt (Jas.). *Consid. on the Use of Factitious Airs.* 3 pts.
1794	Relph (Dr. J.). *Inquiry into the Medical Efficacy of Yellow Bark.*
1794	Pearson (Dr. R.). *Thesaurus Medicaminum.*
1797	Pearson (Dr. R.). *Pract. Synops. of the Mat. Alim. and Mat. Med.* 8vo. 2d. ed. 1808.
1800	Duncan (Dr. A., Jun.). *Edinburgh New Dispensatory.*—11th ed. 1826. *Supplement* 1829.
1800	Saunders (Dr. Wm.). *Treatise on Mineral Waters.* 8vo.
1800	Pearson (John). *Observations on the Effects of various articles of the Materia Medica in the cure of Lues Venerea.* 8vo.
1801	Pearson (Dr. G.). *Arrang. Catal. of the Art. of Food, Drink, Seasoning, and Medicine.* 8vo.
1804	Murray (Dr. J.). *System of Materia Medica and Pharmacy.* 5th edit. 1828. 2 vols. 8vo.
1804	Graves. *Conspectus of the Pharmacopœias.* 12mo. Lond.
1805	Hamilton (Dr. J.). *Observations on Purgative Medicines.* 8vo.
1805	The existence of Cinchonia inferred by Dr. Duncan, jun.
1809	*A Practical Materia Medica.* Lond. small 8vo.
1809	Wilson (J.). *Pharmacopœia Chirurgica.* 8vo.—2d ed. 1811.
1810	Thomson (Dr. A. T.). *Conspectus of the Pharmacopœias.* 13th ed. 1841.
1811	Thomson (Dr. A. T.). *The London Dispensatory.* 8vo. 9th ed. 1837.
1812	Stokes (Dr. Jonathan). *A Botanical Materia Medica.* 4 vols. 8vo.
1812	Paris (Dr. J. A.). *Pharmacologia.* 8vo. 6th ed. 1825.—8th ed. 1833.—*Appendix,* 1838.
1813	Ainslie (Dr. W.). *Mat. Med. of Hindoostan.* 4to.—*Mat. Indica.* 2 vols. 8vo. 1826.
1813	Young (Dr. Thos.). *Classif. and Lit. of Mat. Med.* in the *Introd. to Med. Lit.* 8vo.
1815	Rootsey (S.). *General Dispensatory.* 12mo. Bristol.
1818	Gray (S. F.). *Supplem. to the Pharmacopœias.* 8vo.—6th ed. 1836.
1821	*Medico-Botanical Society of London* established. Some "*Addresses*" and "*Transactions*" have been published by the society, but irregularly.
1826	Gray (S. F.). *The Elements of Pharmacy, and of the Chemical History of the Materia Medica.* 8vo.
1824	Phillips (R.). *Trans. of the Pharm. of the Roy. Coll. of Phys. Lond. with Notes and Illus.* Ditto, 1837.—4th ed. 1841.
1825	Brande (W. T.). *Manual of Pharmacy.* 8vo.—3d ed. 1833.
1826	Rennie (J.). *New Supplem. to the Pharmacopœias.* 8vo.—4th ed. 1837.
1827—30	*Flora Medica.* 2 vols. 8vo.
1829	Christison (Dr. Robt.). *Treat. on Poisons.* 8vo. 3d ed. 1835.
1830	Barker (Dr. F.) and Montgomery (Dr. W. F.). *Observ. Chem. and Pract. on the Dubl. Pharm.* 8vo.
1831	Billing (Dr. A.). *First Principles of Medicine.*—4th ed. 1841.
1831	Bardsley (Dr. J. L.). *Hospital Facts and Observations.*
1831	Stephenson (Dr. J.) and Churchill (J. M.). *Med. Botany.* 4 vols. 8vo. Fig.—2d ed. by G. Burnett, 1834—36.
1831	Kane (R. J.). *Elements of Practical Pharmacy.*
1832	Stephenson (Dr. J.). *Med. Zoology and Mineralogy.* 8vo. 1832.
1832-3	Thomson (Dr. A. T.). *Elem. of Mat. Med. and Therap.* 2 vols. 8vo.—2d ed. in 1 vol. 1835.
1833	Jones (T. W.). *Manual of Pharmacology.* 18mo.
1835	Johnstone (Dr. J.). *A Therapeutical Arrangement and Syllabus of Materia Medica.*
1835—7	Pereira (J.). *Lectures on Materia Medica and Therapeutics* in *London Medical Gazette.*
1836—8	Sigmond (Dr. G. G.). *Lect. on Mat. Med. and Therap.* in the *Lancet.*
1837	Steggall (Dr. J.). *A Text Book of Materia Medica and Therapeutics.* Small 8vo.
1837	Collier (Dr. G. F.). *A Translation of the New Pharmacopœia of the Royal College of Physicians in London, with Notes and Criticisms.* Royal 8vo. Lond.
1838	Lindley (Dr. John). *Flora Medica.* 8vo.
1838	Ure (Dr. Alex.) *Practical Compendium of Mat. Med. adapt. for Infancy and Childhood.*
1839	Collier (Dr. G. F.) *Companion to the London Pharmacopœia.* Royal 8vo.
1839	Brande (W. T.). *Dictionary of Materia Medica and Practical Pharmacy.*
1840	Lane (Dr. J. H.). *Compendium of Materia Medica and Pharmacy.*
1840	Beasley (H.). *The Pocket Formulary and Synopsis of the Pharmacopœias.* 24mo—2d ed. 1841.
1839-40	Pereira (Dr. Jon.) *The Elements of Materia Medica.* 2 vols. 8vo —2d ed. 1842.
1841	Bellingham (Dr. O'Bryen). *Elements of Materia Medica and Pharmacy,* edited by Dr. A. Mitchell. Part I. Dubl. 8vo.
1842	Christison (Dr. R.). *A Dispensatory, or Commentary on the Pharmacopœias of Great Britain.* Edinb.

⁂ Pharmaceutical Transactions, edited by Jacob Bell. Commenced 1841. The Chemist, edited by Mr. Watts, contains many articles on pharmacy. It was commenced in 1840.

A. D.	FRANCE.
1542—4	Sylvius (James).
1566	Antimony proscribed.
1666	Antimony permitted.
1672	Tartarized soda discovered by Seignette.
1686	Ipecacuanha celebrated in Paris.
1694	Pomet (P.). *Hist. Gén. des Drog. des Plantes, &c.* Eng. Transl. 1712.
1697	Lemery (N.). *Pharmacopée Universelle.*
1697	Lemery (N.). *Traité Universel des Drog. simples.*
1713	Simaruba bark sent to Paris.
1708	Tournefort (J. P.). *Materia Medica.*
1709	Chomel (J. B.). *Abrégé de l'Hist. des Plant. usuelles.* 8vo.
1741	Geoffroy (S. F.). *Tract. de Mat. Méd.* 3 vols. 8vo.
1756	Helminthocorton sent to Paris.
1760	Goulard (Thos.) *Traité sur les Effets des Prep. de Plomb.* 8vo. 2 vols.
1762	Baumé (A.). *Elém. de Pharm. theor. et prat.* 2 vols. 8vo.—3me. ed. 1818.
1770	Lieutaud (Jos.). *Précis de la Mat. Méd.* 2 vols. 8vo.
1773	De la Beyrie et Goulin. *Dict. raisonné-univ. de Mat. Méd.* 8 vols. 8vo.
1787	Venel. *Précis de Mat. Méd.* 8vo. 2 vols.
1789	Desbois de Rochefort. *Cours Elém. dé Mat. Méd.* 8vo. 2 vols.
1803	Narcotine discovered by Derosne.
1804	De Candolle (A. P.). *Essai sur les Propr. Méd. des Plantes.* 8vo.—2d ed 1816.
	Alibert (J. L.). *Nouv. Elém. de Thérapeut.* 3 vols. 8vo. 5me ed. 1826.
1805	Schwilgue (C. J. A.). *Traité de Mat. Méd.* 3me ed. 1818. 2 vols. 8vo.
1805	Barbier (J. B. G.). *Princip. Gen. de Pharmacol.—Traité Elém. de Mat. Méd.* 2nde ed. 1824. 3 vols. 8vo.
1806	Chortet (J. J.). *Traité de Pharmacologie.*
1811	Picrotoxin discovered by Boullay.
1811	Virey (J. J.). *Traité de Pharmacie theorique et pratique.* 2 vols. 8vo. Nouv. ed. 1819.
1811	Iodine discovered by Courtois.
1814	The existence of morphia confirmed by Robiquet.
1814	Orfila (P.). *Traité des Poisons; ou Toxicol. Gén.* 3me ed. 1827.
1817—20	Pelletier and Caventou discover emetine, strychnia, brucia, veratria, and quina.
1818	Menard (J. L. M.). *Essai de Mat. Méd. et de Therap.* 8vo.
1819	Martin (C. P.) *Essai de Pharm. gén.* 8vo.
1819	Caventou. *Traité Elém. de Pharm. theoriq.* 8vo.
1819—20	Hanin. *Cours de Mat. Méd.* 8vo. 2 vols.
1820	Virey (J. J.) *Hist. Nat. des Médicam. des Alim. et des Poisons.* 8vo.
1820	Guibourt (N. J. B. G.). *Hist. Abreg. des Drog. simpl.* 8vo. 2 vols. 3me ed.—1836.
1821	Labarraque recommends the chlorides of lime and soda.
1821	Roques (Jos.). *Phytographie Médicale.* 2 vols. 4to.
1821	Magendie (F.). *Formulaire pour la préparation et l'emploi de plusieurs Nouv. Médicam.* 8me ed. 1835.
1823	Richard (A.). *Botanique Médicale.*
1825	Begin (L. J.) *Traité de Thérap.* 8vo. 2 vols.
1826	Meconine discovered by Dublanc jeune.
1826	Edwards (H. M.) and Vavasseur (P.) *Manuel de Mat. Méd.* 1826.—An English Translation of this.
1826	Bromine discovered by Balard.
1827—29	Chevallier (A.), Richard (A.), et Guillemin (J. A.). *Dict. des Drog.* 8vo. 5 vols.
1828	Jourdan (A. J. L.). *Pharmacopée Universelle.* 2 vols. 8vo. 2nde ed. 1840.
1828	Fée (A. L. A.). *Cours d'Hist. Nat. Pharm.* 2 vols. 8vo.
1828	Henry (N. E.), et Guibourt (N. B. G.). *Traité de Pharm. théoriq. et prat.* 8vo. 2 vols. 2me ed. 1834.—3me ed. in 1 vol. 1841.
1828	Martinet (L.). *Manuel de Therap. et de Mat. Méd.* 1828.
1828—37	Bayle (A. L. J.). *Bibliothèq. de Therapeut.* 4 vols. 8vo.
1829	De Smyttère (P. J. E.). *Phytologie pharm. et Med.*
1829	Ratier (F. S.). *Traité de Mat. Méd.* 8vo. 2 vols.
1829—34	Merat (F. V.) et De Lens (A. J.). *Dict. Univ. de Mat. Méd.* 6 vols. 8vo.
1831	Chevallier et Idt. *Manuel du Pharmacien.* 2 vols. 8vo.
1831	Foy (F.). *Cours de Pharmacologie.* 8vo. 2 vols.
1831—5	Richard (A.). *Elémens d'Histoire Naturelle Médicale.* 3 vols. 8vo.
1832	Codeia discovered by Robiquet.
1832	Narceina discovered by Pelletier.
1835	Cottereau (P. L.). *Traité Elém. de Pharm.* 8vo.
1836	Soubeiran (E.). *Nouveau Traité de Pharmacie.* 2 vols.—2nde ed. 1840.
1836—32	Trousseau (A.) et Pidoux (H.). *Traité de Therap. et de Mat. Méd.* t. i. 1826. t. ii. part 1re. 1837. t. ii. part 2e. 1839.
1839	Bouchardat (A.). *Elémens de Matière Medicale.* 8vo.
1839	Galtier (C. P.). *Traité de Matière Médicale et des Indications Thérapeutiques des Medicaments.*
1841	Galtier (C. P.). *Traité de Pharmacologie et de l'Art de formuler.* 1 vol. 8vo.

⁂ Also *Bulletin de Pharmacie*, from 1809 to 1815. *Journal de Pharmacie*, from 1815 to the present time; and *Journal de Chimie Médicale*, from 1825 to the present time.—Also *Journal de Pharmacie du Midi.*

A. D.	GERMANY.
1588	Camerarius (J.). *Hort. Med. et Philosoph.*
1631	Emetic tartar mentioned by Mynsicht.
1658	Sulphate of soda discovered by Glauber.
1669	Phosphorus discovered by Brandt.
1641	Schroeder (J.). *Pharmacopœia Medico Chymica.* 4to.
1679	Wepfer (J. J.). *Historia Cicutæ Aquaticæ.* 4to.
1684	Wedelius (G. W.). *Amæn. Mat. Med.* 4to. 1704.
1681	Nitric ether noticed by Kunkel.
1686	Cascarilla mentioned by Stisser.
1701	Rivinus (A. Q.). *Censura Medicam.* Officin. 4to.
1712	Kæmpfer (E.). *Amænittates exoticæ.* 4to.
1714	Zorn (B.). *Botanologia Medica.* 4to.
1728	Stahl (G. E.). *Materia Medica.* 8vo.
1740	Neumann (Dr. C.). *Prælectiones Chemicæ*, by J. C. Zimmermann; an authentic edition in 1756, under the the title of *Chymia medica, dogmatico-experimentalis;* and his *Chemical Works*, by Dr. Lewis. 4to. 1759.
1740	Hoffmann (F.). *Opera omnia physico-medica.* 6 vols. fol.
1741	Cartheuser (I. F.). *Rudiment. Mat. Med.* 8vo.
1755	Lösecke (I. L. L.). *Mat. Med.* 8vo.
1758	Vogel (Dr. R. A.). *Hist. Mat. Med.* 8vo.
1760	Störck (Ant.), on hemlock, stramonium, aconite, hyoscyamus, and colchicum.
1762	Crantz (H. I. P.). *Mat. Med. Syst.* 8vo. 3 vols. ed. 2nda. 1779.
1774	Spielmann (I. R.). *Institutiones Mat. Med.* 8vo. ed nov. 1784.
1774	Murray (Dr. J. A.). *Apparatus Medicam.* 8vo. ed. alt. cur. Althorf. 1793.
1791	Arnemann (Dr. J.). *Praktische Arzneimittellehre.* 8vo. 6te Aufl. by Kraus. 1819.
	Arnemann (Dr. J.). *Chirurgische Arzneimittellehre.* 6te Aufl. by Kraus. 1818.
1790	Gren (F. A. C.). *Handbuch der Pharmakologie.* 3te Aufl. 1813.
1793	Baldinger (E. G.). *Litteratura Universa Materiæ Medicæ*, &c. 8vo.
1793–7	Schlegel (J. C. T.). *Thesaurus Materiæ Medicæ.* 3 vols. 8vo.
1795—6	Gmelin (J. F.). *Appar. Medicam. regnum minerali complectens.* (See J. A. Murray). 8vo.
1797	Segnitz (F. L.). *Handbuch der praktische Arzneimittellehre.* 8vo.
1797	Jahn (F.). *Auswahl der wirksamsten Arzneimittel.* 8vo.
1800	Swediaur (D. F.). *Materia Medica.* 12mo.
1802	Frank (I. S.). *Versuch einer theoretisch praktischen Arzneimittellehre nach den Principien der Erregungstheorie.* Erlängen.
1803	Oberreich (C F.). *Umriss einer Arzneimittellehre nach den Grundsätzen der Erregungstheorie.*
1804	Morphia and Meconic acid discovered by Sertürner.
1805	Bertele (G. A.). *Handbuch einer dynamischen Arzneimittellhre.* 8vo.
1807—9	Burdach (Dr. K. F.) *System der Arzneymittellehre.* 8vo. 2nd ed. 1817-19.
1808	Wurzer (F.). *Grundriss der Arzneimettellehre.* 8vo.
1808—24	Pfaff (C. H.). *System der Materia Medica nach chemichen Principien.* Leipz. Bd. vij. 8vo.
1809	Ebermaier (Dr. J. C.). *Taschenbuch der Pharmacie.* 8vo.
1809	Müller (J. H.). *Handbuch der Lebens—und Arzneimittellehre.*
1810	Hahnemann. *Organon der rationellen Heilkunde.*
1815	Schöne (K.). *Praktische Arzneimittellehre nach der Grundsätzen der Erregungstheoric.*
1816	Sprengel (Dr. K.). *Institutiones Pharmacologiæ.* 8vo.
1816–17	Voigtel (Dr. F. G.). *Vollständiges System der Arzneimittellehre.* 2 vols. 8vo. Herausg. von Kuhn.
1819—22	Schwartze (Dr. G. W.). *Pharmacologische Tabellen.* fol. 2te Aufl. 1833.
1820	Tiedemann (F.) and Gmelin (L.). *Versuch über die Wege auf welchen Substanzen aus dem Magen und Darmkanal ins Blut gelangen.* Heidelburgh.
1821—3	Vogt (Dr. P. F. W.). *Lehrbuch der Pharmakodynamik.* 2 vols. 8vo. 2 Aufl. 1828.
1824—30	Geiger (P. L.). *Handbuch der Pharmacie.* 3 vols. 8vo. 5 Aufl. 1837.
1824	Niemann (J. F.). *Pharmacopœa Batavacum cum notis et additamentis medico-pharmaceuticis.* Lips. 2 vols. 8vo. 2nd. ed. 1824.
1824	Martius (Dr. C. F. P.). *Specimen Materiæ Medicæ Braziliensis.* 4to.
1825	Jörg (Dr. J. C. G.). *Material. zu einer künft. Arzneimittell.*
1825	Sundelin (Dr. C.). *Handbuch der speciellen Heilmettellehre.* 3te Aufl. 1833.
1825—31	Bischoff (C. H. E.). *Handbuch der Arzneimittellehre.* 3 vols. 8vo.
1826	Bergen (H. von). *Versuch einer Monographie der China.* 4to. plates.
1826—23	Richter (G. A.). *Ausführliche Arzneimittellehre.* 6 vols. 8vo.
1827	Dulk (Dr. F. P.). *Die preussische Pharmacopoe übersetzt und erläutert.* 2 pts. 2nd ed. 8vo. 1829.
1827—28	Hergenröther (Dr. J.). *System der allgemeinen Heilungslehre.* 2 vols. 8vo.
1827—34	Goebel (Dr. F.) and Kunze (Dr. G.). *Pharmaceutische Waarenkunde.* 2 vols. 4to.
1828	Dierbach (Dr. J. H.). *Der neuesten Entdeckungen in der Materia Medica.* 2te Aufl.
1829—34	Hayne. *Darstellung und Beschreib. d. Arzneigewächse welche in d. neue preussisiche Pharmacopöe aufgenommen sind.* Von Brandt & Ratzeburg.
1829	Hartmann (P. C.) *Pharmacologia dynamica.* 2 vols. 8vo.
1829	Nees von Esenbeck (Dr. Th. F. L.), Weyhe (M. F.), Wolter (Dr. J. W.), and Funke (P. W.). *Beschreibung officineller Pflanzen.* fol.
1829—33	Brandt (J. F.) and Ratzeburg (J. F. C.). *Medizinische Zoologie.* 2 vols. 4to.
1829	Michaelis (Dr.). Art. *Arzneimittel.* in the *Encyclopädisches Worterbuch der medicinischen Wissenschaften.*

A. D.	GERMANY.—*Continued.*
1830	Wendt (Dr. J.). *Praktische Materia Medica.* 8vo.
1830	Martius (T. W. C.). *Das Neueste aus dem Gebiete der Pharmacognosie, als Nachtrag zu Guibourt's Waarenkunde mit Berücksichtigung der zweiter Originalausgabe bearbeitet.* Nürnberg.
1830—32	Nees v. Esenbeck (Dr. T. F. L.) and Ebermaier (Dr. C. H.). *Handbuch der medicinisch-pharmaceutischen Botanik.* 2 vols. 8vo.
1830—37	Sachs (L. W.) and Dulk (F. P.). *Handwörterb. d. prakt. Arzneimittell.* 19 Lief. A—St.
1830	Creasote discovered by Reichenbach.
1831—39	Wibmer (Dr. K.). *Die Wirkung der Arzneimittel und Gifte.* 3 vols. and 1st part of the 4th vol.
1831	Pfaff (C. H.). *Pharmacop. Slesvico-Holsatica.* Kiliæ. 4to.
1831	Dierbach (I. H.). *Abhandl. üb. der Arzneikrafte der Pflanzen.* 8vo.
1831	Phoebus (Dr. P.). *Handbuch der Arzneiverordnungslehre.* 2d ed. 2 parts. 1835-6. 3rd ed. 1839, 1840. The first edition was entitled, "*Specielle Receptirkunst.*"
1832.	Zenker (Dr. J. C.) and Schenk (Dr. E.) *Naturgeschichte der vorzüglichsten Handelspflanzen.* 2 vols. 4to.
1833	Schroff (Drs. E. S. & K. D.). *Arzneimittellehre und Receptirkunst.* 12mo.
1832	Martius (Dr. T. W. C.). *Grundriss d. Pharmakogn. d. Pflanzenreichs.* 8vo.
1834	Brandt (I. F.) and Ratzeburg (J. F. C.) *Deutschl. phanerog. Giftegewachse.* 4to.
1836	Radius (Dr. J.). *Auserlesene Heilformeln.*
1837	Dierbach (Dr. J. H.). *Die neuesten Entdeckungen in der Materia Medica.* 1st vol.
1837	Bachmann (W. L.) *Handwörterb. d. prakt. Apothekerkunst.* 2 vols.
1837	Mitscherlich (Dr. C. G.) *Lehrbuch der Arzneimittellehre.* First part of 1st vol. 1837.
1837—38	Grabau (Dr. W.). *Chemisch-physiologisches System der Pharmakodynamik.* 2 pts. 8vo. Kiel.
1838—41	Winkler (Edw.). *Vollstandiges Real Lexicon der medicinisch-pharmaceutischen Naturgeschichte und Rohwaarenkunde.* 8vo. Leipzig. 1^{es} Heft, 1830; 10 Heft, 1841.
1838	Martius (Dr. T. W. C.). *Lehrb. d. pharmaceut. Zoologie.* 8vo.
1838	Phoebus (Dr. P.). *Deutschl. kryptog. Giftgewachse.* 4to.
1839	Schwartze (Dr. G. W.) *Allgem. u. spec. Heilquellenlehre.* 2 parts. Folio.

⁂ A considerable number of pharmaceutical journals are published in Germany. The following are, perhaps, the most important:—

1. *Almanach oder Taschenbuch für Schiede-Küntsler und Apotheker.* 12mo. From 1780.
2. *Berlinisches Jahrbuch für die Pharmacie und für die damit verbundenen Wissenschaften* 12mo. (From 1795 to the present time). Now edited by Dr. Lindes.
3. Trommsdorff (J. B.). *Journal der Pharmacie.* 8vo. 1794 to 1817. *Neues Journal, der Pharmacie.* From 1817 to the present time.
4. Büchner (J. A.). *Repertorium für die Pharmacie.* 12mo. (From 1815 to the present time).
5. *Pharmaceutisches Central-Blatt.* 8vo. From 1830 to the present time. Edited by by Dr. A. Weinlig.
6. *Annalen der Pharmacie.* 8vo. From 1832 to the present time. A continuation of the *Magazin für Pharmacie.* From 1823—1831.
7. *Archiv der Pharmacie.* From 1822 to the present time. 8vo. Edited by R. Brandes and H. Wackenroder.
8. *Jahrbuch für praktische Pharmacie.* 8vo. 1838. By Drs. J. E. Herberger and F. L. Winckler.

A. D.	**HOLLAND.**
1517—85	Dodonæus (R.).
1577—1644	Van Helmont (John B.).
1605	Clusius (C.). *Exoticorum.* libr. x. Lugd. fol.
1648	Piso (G.). *De Medicina Brasiliensi.* Mentions ipecacuanha, copaiba, tapioca, &c.
1674	Marggravius (C.). *Mat. Med. Contract.* Amst. 4to. ed. 2nda. 1682.
1719	Boerhaave (H.). *Mat. Med. et Remed. Form.* Ludg. 8vo.
1740	De Gorter (D.). *Mat. Med. exhibens virium medicamentorum catalogus.* Amst. 5to.
1793	Balthasaar (A.). *Verkorte doch klaare en oefennende Materia Medica.* Amst. 8vo.
1757—1802	Voltelen (F. J.). *Pharmacologiæ Universæ.* 3 parts. Lugd. 8vo.
1799	Ypey (A.). *Introductio in Materiam Medicam.* Lugd. 8vo.
1811	Ypey (H.), *Handboek der Materies Medica.* Amst. 8vo.
1817	Van Honte (J. A.). *Handleiding tot de Materies Medica, of Leer der Geneesmiddeln.* Amst. 8vo.
1829	Van Water (J. A.). *Beknopt doch zoo veel mogelijk volledig Handboek voor de Leer der Geneesmiddeln.* Amst. 8vo.

☞ See C. H. à Roy, Catalogus Bibliothecæ Medicæ, t. ii. Amstel. 1830.

BELGIUM.

A. D.	
1824	**Kluyskens** (J. F.). *Matière Médicale pratique.* Gand. 2 vols. 8vo.

SCANDINAVIA.

(Denmark, Norway, and Sweden.)

1. Denmark.

A. D.	
1640	**Pauli** (Simon) *Quadripartitum botanicum de simplicium medicamentorum facultatibus.* Rostochii 4to. Argent. 1667. 1668. 1675. 1708.
1658	**Bartholinus** (C. Th.), *Dispensatorium Hafniense.* Hafn. 4to.
1772—1840	*Pharmacopœa Danica.* Hafn. 1772. 1786. 1805. 1840.
1788	**Bang** (Fr. L.), *Pharmacopœa in usum Nosocomii Fridericani.* Havn. 12mo.
1799	**Mangor** (C. E.), *Pharmacopœa Pauperum.* Hafn. 4to.
1800	**Mangor** (C. E.), *Armenapothek.* Hafn.
1804	**Tychsen** (Nicolai), *Theoretisk og praktisk Anviisning til Apothekerkunsten.* Udg. ved J. F. Bergsoe. Kbhn. 1 & 2 D. 8vo.
1809—10	**Mynster** (O. H.), *Pharmacologie.* Kbhn. 2 D. 8vo.
1810—12	**Wendt** (J. C. W.), *Anviisning til at samle, törre og conservere medicinske Planter og Plantedele.* Kbhn. 8vo.
1811	**Wendt** (J. C. W.), *Anviisning til Recepteerkunsten.* Kbhn. 8vo.
1813	*Pharmacopœa militaris.* Kbhn. 12mo.
1828	*Pharmacop. in praxi publ. a med. Dan. sequenda.* Hafn.
1834—5	**Djörup** (M.), *Haandbog i Pharmacologien.* Kbhn. 8vo. 2 D. 2 Udg. 1837-8.
1838	**Otto** (Carl), *Haandbog i Toxikologien.* Kbhn. 8vo.

⁂ Many articles on pharmacology will be found in the following Danish medical journals:—
1. "Bibliothek for Læger." 1809—1839. Kbhn. 30 vol. 8vo.
2. "Hygæa." Udvigel ved Otto. 1826-7.
3. "Medicinsk-chirurgiske Tidskrift."
4. "Ugeskrift for Lægar." 1839.

☞ For further information respecting Danish and Norwegian works on pharmacology consult:—
Winther (M.) "Bibliotheca Danorum Medica Hafniæ." 1832.

2. Norway.

The Danish and Norwegian literature was common to both countries till their political separation in 1814, when Norway was united with Sweden. The language used in Norway in writing, and by all educated persons, in speaking, is identical with the Danish. Hence, then, every medical work published in Denmark till 1814 may be considered as also belonging to Norwegian literature. Since that year no work on pharmacology has been published in Norway. The King has, however, appointed a committee to prepare a new pharmacopœia for that country. The *Pharmacopœa Danica* has hitherto been used there. Several articles on pharmacology have appeared in the following Norwegian periodical:—*Eyr, et medicinsk Tidskrift.* 11 vols. Commenced in 1826, and continued by Dr. Holst till 1837.

3. Sweden.

A. D.	
1686	*Pharmacopœa Holmiensis.* Holmiæ, 4to.
1705—1817	*Pharmacopœa Suecica.* Holm. 1705. 1775. Alt. 1776. Holm. 1779. 1817. 4to. and 8vo.
1749	**Linne'** (C. A.) *Materia Medica.* Stockh. 8vo. ed Schreb. 1772. 1782. 1787.
1735—1784	**Bergmann** (T.), A distinguished chemist.
1769	**Retzius** (A. J.) *Kort begrep af grunderne til Pharmacien.* Stockholm, 1769. 8vo.
1742—1786	**Scheele** (C. W.). Discovered Tartaric Acid in 1770, Chlorine in 1774, solid Citric Acid in 1781, and hydrous Prussic Acid.
1771	**Retzius** (A. J.), *Primæ lineæ Pharmaciæ, suecico idiomate editæ, jam Latine conversæ.* Göttingæ. 8vo.
1776	**Bergius** (P. J.), *Materia Medica e Regno Vegetabili.* Ed. 2. T. 8vo., Stockh. 1782.
1789	*Pharmacop. milit. nav. et eorum usui accommod., qui impensis publ. curantur.* Holm. 1789. 8vo.
1825—25	**Ronander** (C. W. H.), *System e Pharmacologien.* Stockholm. 1 Deel; 1, 2. Afdeling.
1834	*Pharmacopœa in usum Nosoc. milit. Holm.* Holm. 1834. 12mo.
	Berzelius.

⁂ Besides several pharmacological papers in the following Swedish journals:—
"Svenska Läkare—Sällskapets Handlingar" Stockh. 1813—1833. 8vo. "Nija Handlingar" 1 Bd. 1837.
"Svenska Läkare—Sällskapets Arsberättesser." Stockh. 1813—1838. 8vo. 20 vol.
"Tidskrift för Läkare och Pharmaceuter." Stockh. 1832—1838. 8vo. 6 vol.
"Hygæa. Medicinisk og Pharmaceutisk Mönadskrift." Commenced April 1839.

RUSSIA.

A.D.	
1534	Herbal in the Russian language with figures.
1588	Treatise on medicines in ditto.
1665	Apothecaries' Garden at Moscow.
1778	*Pharm. Rossica.* Petropol. 4to.—1782. 8vo.
	Pharm. castrens. Rossica. Petropol. 4to.
1784	Bacherach (A.). *Pharm. Rossica navalis.* Petrop. 8vo.
1801	Grindel (D. H.). *Grundriss d. Pharm.* Riga.
1803—8	——————— *Russiches Jahrbuch d. Pharm.* Riga.
1806	Giese (F.). *Lehrb. d. Pharm.* Riga.
1807	*Pharmacopeia in usum Nosocomii Paup. Petropol.* 8vo.
1809—10	Giese (F.) and Grindel (D. H.). *Russ. Jahrb. d. Chem. und Pharm.* 2 Bde. Riga. 1809.—Dorpat. 1810. 8vo.
1819	Grindel (D. H.). *Med. pharm. Blatter.* 8 Hefte. Riga. 1819 and 1820. 8vo.
1829	Horaninow (P.). *Systema Pharmacodynamicum.* 8vo. Petrop.
1840	Wylie (Sir James). *Pharmacopœia castrensis Ruthenica.* Ed. 4to. Petropoli.

☞ Further information on Russian medicine may be obtained in the following works:—
Grahl (J. F.). "Diss. Med. sistem quædem medicam. Rossor. domest." Jenæ. 1790.
Richter (W. M.). "Geschichte d. Med. in Russl." Bd. 3. 1813—1817. Moskwa.

FINLAND.

A.D.	
1797	Björnlund (B.). *Mat. Med. Select.* 8vo. Abo.
1819	*Pharmacopœa Fennica.* Aboæ.

ITALY.

A.D.	
1500—55	Brassavola (A. M.). *Examen omnium simplicium.*
1501—77	Matthiolus (P. A.). *Commentarii in libros sex Dioscoridis.*
1502—53	Serveto (M.).
1502	Valerian recommended in epilepsy by Columna.
1553—1616	Alpinus (Prosper). On the medicine and plants of the Egyptians.
1647	Sala (Ang.).
1707	Sugar of milk made known by Testi. (Beckmann, *Hist. and Invent.* iv. 602.)
1734	Mazini (J. B.) *Mechanica Medicamentorum.*
1791—5	Carminati (B.). *Hygiene, Terapeutice et Materia Medica.* 4 vols. 8vo. Papia.
1803	Brugnatelli (F.). *Farmacopea ad Uso degli Speziali, e Medici moderni d'Italia.* 8vo. Venez.—A French translation by Planche in 1811.
1808	Doctrine of contra-stimulus by Rasori and Borda.
1821	Targioni *Di Materia Medica Tozzeti Lezioni di.* Firenze. 8vo.
1824	Alberti (A.). *Flora Medica.* 6 vols. 8vo. Milan.
1824	Ambrosiani (P.) *Manuale por Droghiere.* Pavia, 2 vols. 8vo.
1825	*Trattato delle Droghe semplici.* 6 vols. Milan.
1825	Stellati (V.). *Elementi di Mat. Med.* 2 vols. 8vo. Napoli.
1826—7	Taddei. *Farmacopea generale.* 4 vols. 8vo. Firenze.
1827	*Dizionnario de Medicamenti.* Modena.
1827	*Dizionnario farmaceutico galeno-chemico.* Neapl.
1827	Barzelotti (I.). *Epitome delle istruzioni theoretico-pratiche.* 8vo. Pisa.
1828	Bruschi (D.). *Institutioni di Materia Medica.*
1830	Argenziano (P.). *Elementi di Materia Medica.* Napoli.
1833	Vigna (C.). *Manuale di Mat. Med.*
1833	Giacomini (G.). *Trattato filosofico sperimentale dei Soccorsi Terapeutici.* 4 vols. 8vo. Padova.
1833	Folchi (I.). *Materiæ Medicæ compend.* 2 vols. 8vo. Ad Thermas Agrippæ.
1837—40	Taddei (Dr. G.) *Elementi di Farmacologia sulle bali deila chimica.* Ediz. 2nda. 4 vols. 8vo. Firenze.

SPAIN.

A.D.	
1569	Monardez (Nic.). *Historia medicinal de las cosas que se traen de nuestras Indias Occidentales que sirven en medicina.* Sevil. 4to. Lat. transl. by Clusius 1574. Antw. Engl. Transl. by Frampton Lond. 1580.—Monardes mentions Cebadilla, Sarsaparilla (çarçaparilla), Sassafras, Balsam of Peru, Balsam of Tolu, Logwood, &c.
1578	Acosta (Chr.). *Drogas de las Indias.* 4to. Burgos.
1615	Hernandez (*Fr.*). *Nova plant. anim. min. Mexican. historia.* Rom. 1651. Fol.—(A Spanish edit. by F. Ximenes in 1615.)
1632	Cinchona imported into Spain.
1729	*Pharm. Madritensis,* 4to. 1794. 8vo. 1798. Lips. 1822.
	Ruiz (Don Hipp.) and Pavon (Don Jose). *Flora Peruviana.* Cinchona, Krameria.
1786	Tavares (Fr.). *De pharmacologia libellus.* Coimbra. 8vo.
1787	Roderiguez y Salv. Soliva (J.), *Des efficaces virtudes nuevamente descubiertas o comprob. en varias plantas.* Madrid.
1789	Rancé (J.). *Tratado theor. prat. de Mat. Med.* Barcelona. 1789.
1798	Hernandez de Gregorio (M.), *Diccionario dem. de Farmacia.* Madrid. 4to.
1800	Carbonel (F.). *Pharmaciæ elementa, chem. recent. fundament. innixa.* Barcinon.—French transl. by J. H. Cloquet, from the 3d ed. Paris, 1821.
1841	Iimenez (Dr. M.). A work on pharmacy in 2 vols.; but I have not seen it.

PORTUGAL.

A.D.	
1536	**Garcias ab Orta**, *Coloquios dos simples y droguas he cousas medicinais da India.* Goa. 4to.—Lat. transl. by Clusius, 1567. Antw. 8vo.
1785	**Henriquez de Paiva** (J. J.). *Pharm. Lisbonn.* Lisb. 8vo.
1794	*Pharmacopeia Geral para o Reino e Dominios de Portugal.* 8vo. 2 vols. Lisbon.
1797	*Pharmacopeia do Pinto.* Coimbra.
1800	**Brotero** described the Ipecacuanha plant.
1810	**Gomes** obtained crystallized Cinchonia.
1836	**Albano** (Dr.) *O Codigo Pharmaceutica ou Tratado do Pharmacia.* Coimbra.

☞ A pharmaceutical journal is published at Lisbon, under the title of "Jornal da Sociedade Pharmaceutica Lusitana." Of this I have seen one number only, viz. "Tomo II. 6º Anno Numero X." Lisboa 1839. It is published monthly.

UNITED STATES OF AMERICA.

A.D.	
1768	Chair of Materia Medica and Botany in the University of Pennsylvania established (Dr. Wood's *Address*, 1836).
1782	Botany separated from Materia Medica in that University.
1801	**Barton** (Dr. B. S.) *Collections for an Essay towards a Materia Medica of the United States.* 3rd ed. 1810.
1803	Chimaphila introduced by Dr. Mitchell.
1806	**Coxe** (Dr. J. R.). *The American Dispensatory.* 8vo. 1806. 8th ed. 1830.
1807	Ergot of Rye introduced by Dr. Stearns.
	Lobelia inflata introduced by the Rev. Dr. Cutler.
1810	**Thacker** (Dr. J.). *American New Dispensatory.* 8vo. 2nd ed. 1813.
1817	**Chapman** (Dr. N.). *Elements of Therapeutics and Mat. Med.* 4th ed. 1825. 2 vols. 8vo.
1817—18	**Barton** (Dr. W. P. C.). *Vegetable Materia Medica of the United States.* 2 vols. 4to. fig. 2nd ed. 1825.
1817—21	**Bigelow** (Dr. J.). *American Medical Botany.* 2 vols. 8vo. Boston.
1822	**Eberle** (Dr. J.). *Treatise on Mat. Med. and Therapeutics.* 2nd ed. 1824. 2 vols. 8vo.
1822	**Bigelow** (Dr. J.). *A Treatise on the Materia Medica, intended as a sequel to the Pharmacopœia of the United States.* Boston.
1827	*Eclectic and General Dispensatory.* Philadelphia.
1828—30	**Rafinesque** (C. S.). *Medical Botany of the United States of North America.* 2 vols. 12mo. Philadelphia
1830	The Jalap plant (*Ipomœa purga*) described by Mr. Nuttal.
1830—34	*Journal of the Philadelphia College of Pharmacy.* Ed. by B. **Ellis**. 1830—183. 46 vols. 8vo. Philad.
1831	*The Pharmacopœia of the United States of America.* By authority of the National Medical Convention, held at Washington A.D. 1830.
1831	**Carpenter** (G. W.). *Essays on some of the most important Articles of the Materia Medica.* 12mo. Philadelphia.
1833	**Wood** (Dr. G. B.), and **Bache** (Dr. F.). *The Dispensatory of the United States.* 3rd ed. 1836.
	Dunglison (Dr. R.). *General Therapeutics, or Principles of Medical Practice, with Tables of the chief remedial agents, and their preparations.*
1834	**Ewell.** *Materia Medica* in connection with his *Medical Companion.*
1835	*American Journal of Pharmacy.* Published under the auspices of the Philadelphia College of Pharmacy. (A continuation of the *Journal of the Philadelphia College of Pharmacy*). From 1835 to the present time. 8vo.
1838	**Togno.** *Manual of Materia Medica.*
1840	**Dunglison** (Dr. R.). *New Remedies: the method of preparing and administering them; their effects on the healthy and diseased economy.* 3rd ed. 8vo. Philadelphia.
1841	**Thomson** (Sam.) *The Thomsonian Materia Medica,* or *Botanic Family Physician.* 8vo. 12th ed. pp. 834. 1841. [Trash. Written by a quack (alluded to at p. 1341), who was tried in America in 1809, for poisoning by the use of Lobelia].

THE

ELEMENTS

OF

MATERIA MEDICA.

Part First.

THERAPEIA GENERALIS.—GENERAL THERAPEUTICS.

Therapeutics (*Therapeia*, *Therapeutice*, *Therapeutica*, from θεραπεύω, *I cure*) is that branch of medicine which has for its object the treatment of diseases. It is divided into *general (Therapeia generalis)* and *special* (*Therapeia specialis*).

Authors are not agreed as to the proper limits of Therapeutics. In the most extended sense of the word, and which I have adopted in the text, it embraces all the known means of cure, and, consequently, all surgical operations. Guersent[a], however, excludes Amputations, Lithotomy, Tracheotomy, &c. from its domains, though he includes Bloodletting, Issues, Setons, Acupuncture, and all those operations which are useful in the treatment of diseases, by producing modifications of the vital properties.

Sprengel[b] applies the term *Iatreusologia* (from ἰατρεύω, *I cure;* and λόγος, *a discourse*) to general Therapeutics.

Acology (*Acologia*, from ἄκος, *a remedy*, and λόγος), or *Iamatologia*[c] (from ἴαμα, *a remedy*, and λόγος), is that department of Therapeutics devoted to the consideration of remedies.

Some authors[d] limit Acology to the consideration of surgical and mechanical remedies.

Remedies (*Remedia*, from *re* and *medeor*, I heal; *Auxilia medica*) are agents used in palliating or curing diseases.

They are of two kinds: *psychical*, or *mental;* and *somatical*, or *corporal.* The first affect the bodily functions, and influence disease by the agency of the mind; the second act on the body directly[e].

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[a] *Dictionnaire de Médecine*, tom. xx. art. *Thérapeutique.* 1828.

[b] *Institutiones Medicæ*, tom. i. p. 7.

[c] C. H. E. Bischoff, *Die Lehre von den chemischen Heilmitteln.* Bd. i. S. 22. Bonn, 1825.

[d] Sprengel; and C. H. E. Bischoff; *op. supra cit.*

[e] Strictly speaking, this division may, perhaps, be inaccurate. We know that changes in the condition of the brain produce corresponding alterations in the state of the mind; and it may be fairly inferred, that changes in the state of the mental faculties are necessarily associated with some molecular alteration in the cerebral substance. If this be true, all remedies are somatical or corporal. But, in the absence of direct and positive evidence of this, we may continue to speak of *mental* as distinguished from *corporal* agents, just as we speak of *functional* as distinguished from *organic* diseases.

1. REMEDIA PSYCHICA.—PSYCHICAL OR MENTAL REMEDIES.

Affections of the mind influence the corporal functions[f], favour or oppose the action of morbific causes on the system, and modify the progress of diseases. Their employment as therapeutical agents is necessarily limited; on account of the difficulty experienced in producing, regulating, and controlling them. Yet they are by no means unimportant, or to be neglected.

They may be conveniently divided into two sets or classes,—the one including those affections which immediately result from the presence of objects external to the mind, and which may be denominated *external affections;*—the other comprising those affections which arise in consequence of certain preceding affections of the mind itself, and which may be termed *internal affections*[g].

CLASS 1. *EXTERNAL AFFECTIONS OF THE MIND.*—To this division belong those phenomena or states of the mind commonly termed *sensations*, and which may arise either from influences external to the body (*external sensations*), or from organic causes existing within the body (*internal sensations*). They suggest, by the association of ideas, other affections, which, as they arise from preceding states of the mind, are truly internal. But, in considering external affections as remedial agents, it is scarcely possible to estimate their influence independent of the internal affections which immediately arise from them. Indeed, the great remedial value of some external affections depends on the internal affections which they suggest; as in the case of Music, the therapeutical effects of which are referrible, not to the mere perception of the sounds, but to the resulting emotions.

The mental affections of this class, which will require a brief notice, are the external sensations; viz. those ascribed to the organs of smell, taste, hearing, vision, and touch.

1. & 2. SMELL AND TASTE.—α. An important object in the art of prescribing is to cover the unpleasant taste and smell of medicines by other substances possessed of an agreeable flavour and odour.

β. In some nervous affections we endeavour to increase the faith of our patients in the powerful agency of the remedies employed, by augmenting the odorous and sapid qualities of the substances used.

3. HEARING.—α. Monotonous noises favour sleep; as the humming of bees, the ticking of a clock, the murmur of a rivulet, a dull discourse, &c. We avail ourselves of this fact in therapeutics, and combat want of sleep by directing an attendant to read aloud to our patient.

β. Silence frequently disposes to sleep. Under some circumstances, however, it "may become a stimulus, while sound ceases to be so. Thus, a miller being very ill, his mill was stopped, that he might not be disturbed by its noise; but this, so far from inducing sleep, prevented it altogether; and it did not take place till the mill was set a-going again[h]."

γ. *Music* has been employed in the treatment of diseases (especially those of the mind) from very remote times (F. A. Steinbeck, *Diss. Inaug. De Musices*

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[f] For some pertinent observations on the powerful influence of mental causes in deranging the functions of the body, see Dr. J. Johnson's *Essay on Indigestion*, 10th ed. 1840.

[g] On this subject consult Dr. Thomas Brown's *Lectures on the Philosophy of the Human Mind*, vol. i. p. 341. 2d ed. 1824.

[h] Dr. Robert Macnish's *Philosophy of Sleep*, p. 32. Glasg. 1830.

atque Poësos, Berol. 1826). The most ancient notice of its remedial use occurs in the Bible[i], where the Sacred Historian tells us that David cured the melancholy of Saul by music. This happened more than a thousand years before Christ. The ancient Greeks also had recourse to music in medicine, though Hippocrates makes no mention of it. It would appear to be principally adapted for the relief of the melancholic form of insanity; but its beneficial effects are very transitory, and have been greatly exaggerated. Esquirol[k] tried it at Charenton in every way, and under the most favourable circumstances, but with little success. "Sometimes," he reports, "it rendered the patients furious, often it appeared to divert them, but I cannot affirm that it contributed to their recovery. To the convalescent, however, it proved advantageous." A more recent writer (Dr. Conolly) also observes[l], that "little regard is probably due to music as a remedial means, its effects being usually only temporary. Violent patients often become silent, and then moved to weeping, when the piano is played to them."—As, in the therapeutical employment of music in insanity, our object is to create agreeable emotions, by recalling the happy events of by-gone times, and by restoring old associations and trains of thought, particular attention should be paid to adapt the character of the music to the peculiarities of each case; for it is obvious that what may prove beneficial to one patient, may be injurious to another.

4. Vision.—*α*. Sleep is promoted by "the sight of any thing waving; as of a field of standing corn, or of the hand drawn up and down before the face by a mesmeriser, attracting attention much more than an object at rest[m]."

β. Absence of light is one of the circumstances which usually dispose to sleep.

5. Touch.—*α*. Gentle friction[n] with the fingers, on some part of the body, disposes to sleep. Its soothing and lulling effects I have repeatedly experienced when suffering with severe headache. "I know a lady," says Dr. Elliotson[o], "who often remains awake, in spite of every thing, till her husband very gently rubs her foot: and, by asserting to a patient my conviction that the secret of an advertising *hypnologist*, whom I allowed to try his art upon the sleepless individual, and which he did for a time successfully, was to make him rub some part of his body till he slept, he confessed this to be the fact."

β. "Gentle friction acts on the same sense; and a combination is still more effective: whence experience has taught nurses to rock, and otherwise agitate infants, while they hum them to sleep[p]."

γ. Freedom from pain and uneasiness of any kind favours sleep.

δ. In some soporose affections, as poisoning by opium, apoplexy, &c. remedies are resorted to which, by exciting the sensibility of the body, are calculated to rouse the patient. Various methods of causing pain have been devised: one of the oldest is *urtication*, or flagellation by a bunch of nettles (*Urtica dioica*). This practice is mentioned by Celsus[q].

Class 2. *Internal Affections of the Mind*.—This class includes the *intellectual states of the mind* and our *emotions*. But, as the observations which I have to make on the therapeutic employment of this class, are rather general than specific, it will be unnecessary to attempt any systematic division of the internal affections.

α. An important part of the treatment of mental affections, as well as of many corporal derangements, is *the removal of all moral or mental circumstances which*

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[i] 1 *Samuel*, xvi. 15—23.

[k] *Des Maladies Mentales*, tom. ii. p. 538. Paris, 1838.

[l] *The Report of the Resident Physician of the Hanwell Lunatic Asylum, presented to the Court of Quarter Sessions for Middlesex, at the Middlesex Sessions*, 1840.

[m] Dr. Elliotson's *Human Physiology*, p. 608, 5th ed. 1840.

[n] The friction above referred to should be very light and gentle.—Strong or violent friction by the hand or horse-hair gloves is used for other purposes; as, for allaying itching and irritation of skin, and promoting cutaneous circulation. Dinneford's "*Patent improved Electrical Horse-hair Renovators*" are, for these purposes, a great improvement over the ordinary horse-hair gloves.—On the subject of Friction as a remedial agent, the student may consult Celsus, lib. ii. cap. 14.

[o] *Op. cit.* p. 609.

[p] Ibid.

[q] Lib. iii. cap. 2.

either have produced or keep up the morbid condition. This, however, cannot be effected in many cases, or only with extreme difficulty. In a considerable number of nervous and hypochondriacal affections, *appeals to the reasoning faculties* are not only useless, but, in many instances, absolutely injurious, "by exciting irritation in the mind of the sufferer, who thinks his counsellers are either unfeeling or incredulous towards his complaints[r]." In such cases no remedy is equal to *travelling*, especially in a mountainous country; for it combines the salutary influence of abstraction of mind from painful reflections, change of scene, respiration of pure air, and employment of bodily exercise. If the extent of the mental disorder, or the circumstances of the patient, preclude the trial of this remedy, *removal from home* is calculated to act beneficially, by withdrawing the patient from the influence of domestic circumstances calculated to add to, or at least to keep up, the morbid condition, and by presenting new objects to his view, which arrest his attention, and excite new trains of ideas[s]. In lunatic asylums, *seclusion* proves a simple but most valuable means of tranquillizing violent maniacs[t]. *Amusement* and *employment* are powerful psychical remedies in the treatment of the insane[u].

β. Emotions and passions of the mind have a most powerful influence upon the disorders of the body[x]. Much of the evidence, however, which establishes the truth of this statement, is rather curious than practically useful, and as the general fact is well known and admitted, I shall confine myself to a few practical illustrations. *Hope* is a mildly stimulating or tonic passion, which may be beneficially employed in all diseases, and which proves injurious in few, if in any cases. Most patients receive with satisfaction and benefit assurances of the prospect of recovery from their medical attendant. Even in diseases of a mortal character, life may be sometimes prolonged by concealing from the sufferer the fatal nature of his malady[y]. *Faith* in the beneficial agency of the remedies employed, and *confidence* in the skill of the medical attendant, are important adjuvants in the treatment of most diseases. To them both physician and empiric owe part of their success; and it is, therefore, the duty of the practitioner to encourage these feelings in his patient by every legitimate and honourable means. The influence of the *imagination* on disease has long been known, and is a fruitful source of fallacy in therapeutics. Extraordinary cures have frequently been ascribed to inert and useless means, when, in fact, they were referrible to the influence of the imagination[z]. *Fear* is a depressing and debilitating passion, of whose power over disease the practitioner has sometimes availed himself. Thus Boerhaave prevented the recurrence of epileptic attacks (brought on by a person falling down in a fit in the sight of the hospital patients,) by directing a red-hot iron to be applied to the person who should next be affected[a].

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[r] *Change of Air, or the Pursuit of Health and Recreation; illustrating the beneficial influence of bodily exercise, change of scene, pure air, and temporary relaxation, in sickness and in health.* By James Johnson, M.D. 4th ed. 1838.

[s] On this subject consult Esquirol, *op. supra cit.* tom. ii. p. 743.

[t] See Dr. Conolly's *Report* before referred to, p. 53.—*Bodily coercion* is now no longer resorted to at the Hanwell Lunatic Asylum. Further experience, however, is still required to establish the propriety or even humanity of omitting it in *all* cases.

[u] Consult Sir W. C. Ellis's *Treatise on the Nature, Symptoms, Causes, and Treatment of Insanity,* 1838; and Dr. Conolly's *Report* before quoted, p. 51.

[x] See Dr. Wm. Falconer's *Dissertation on the Influence of the Passions upon Disorders of the Body.* 2d ed. London, 1791.

[y] For some judicious remarks, by Sir H. Halford, on the duty of the physician, in withholding from, or communicating to, a patient the probable issue of a disease displaying mortal symptoms, see *London Medical Gazette,* vol. vii. p. 602. I fully agree with the learned President of the College of Physicians, that the first duty of the physician is "to protract the life of his patient by all practicable means."

[z] See Dr. Haygarth's *Of the Imagination, as a Cause and a Cure of Disorders of the Body; exemplified by fictitious Tractors and epidemical Convulsions;* in the *London Medical Review,* vol. iii. p. 28, 1800. Also Dr. Lind's *Treatise on the Scurvy,* p. 343, et seq.; and p. 535. 3d ed. 1772.

[a] Falconer's *Dissert.* before quoted, p. 100.

2. REMEDIA SOMATICA.—SOMATICAL OR CORPORAL REMEDIES.

Those remedies which act on the body directly, and which we have denominated Somatical or Corporal, admit of arrangement into four classes, as follows:—

I. *Physical but Imponderable Agents*, as Light, Heat, Electricity, and Magnetism.
II. *Hygienic Agents*, as Diet, Exercise, and Climate.
III. *Mechanical and Surgical Agents.*
IV. *Pharmacological Agents* or *Medicines.*

I. AGENTIA PHYSICA.—PHYSICAL BUT IMPONDERABLE AGENTS.

1. LUX.—LIGHT.

(Lumen.)

PHYSIOLOGICAL EFFECTS.—Light acts as a vivifying or vital stimulus[b] to living beings. It promotes the nutritive processes of vegetables, and its absence is the cause of that curious phenomenon denominated the *sleep of plants*. A morbid condition, called *etiolation*, or *blanching*, is induced in vegetables by growing them in obscure places[c]. On animals, light operates in a two-fold manner: it promotes their development and nutrition, and it acts as a specific stimulus to the eye, as the organ of vision[d]. Privation of light disposes to inactivity and sleep. The disease, called *Anæmia* or *Hypæmia* in man, is analogous to the condition termed etiolation in vegetables; and, like the latter, is sometimes referrible to deprivation of light, combined, however, with other deleterious causes[e]. Blindness (retinitis?) occasionally results from the exposure of the eye to strong light. The effect of the sun-stroke (*coup de soleil*, or *ictus solaris*), in inducing inflammation of the brain, may be, in part, perhaps, owing to the influence of the light of the solar rays.

USES.—In maladies characterized by imperfect nutrition and sanguification, as scrofula, rickets, and anæmia, and in weakly subjects with œdematous limbs, &c. free exposure to solar light is indicated. Its use is sometimes attended with very happy effects. Open and elevated situations probably owe part of their healthy qualities to their position with regard to solar light. The observations of Dr. Edwards, on the influence of light in promoting the perfect development of animals, led him to conclude, that in climates, where nudity is not incompatible with health, exposure of the whole surface of the body to light is favourable to the regular conformation of the body; and he, therefore, has suggested insolation in the open air as a means calculated to restore healthy conformation in children affected with scrofula, whose deviations of form do not appear to be incurable[f].

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[b] The phrase *vivifying* or *vital stimuli* is used to designate those external conditions necessary to the maintenance of life in organized beings; such as heat, air, water, and nutriment. They are to be distinguished from the *alterative* or *medicinal stimuli*, which, while they cause temporary excitement, ultimately exhaust (See Müller's *Elements of Physiology*, by Baly, vol. i. pp. 28 and 57).

[c] For details respecting the influence of light on vegetation, consult J. C. Ebermaier, *Versuch einer Geschichte des Lichtes*, Osnabrück, 1799; Landgrebe, *Ueber das Licht vorzugsweise über die chemischen und physiologischen Wirkungen desselben*, p. 187, Marburg, 1834.—Also De Candolle, *Physiologie végétale*, t. iii. p. 1069, Paris, 1832.

[d] On the influence of light on animals, see J. C. Ebermaier, *op. supra cit.*; E. Horn, *Uber die Wirkungen des Lichts auf den lebenden menschlichen Körper*, Königsberg, 1799; Landgrebe, *op. supra cit.* p. 370; and W. F. Edwards, *De l'Influence des Agens physiques sur la Vie*, Paris, 1824, p. 394.

[e] See the case of the workmen employed in a French coal-mine, detailed in the *Dictionnaire de Médecine*, art. *Anémie;* and M. Andral's *Treatise on Pathological Anatomy*, translated by Drs. Townsend and West, vol. i. p. 97.—" When a gardener wishes to etiolate, that is, to blanch, soften, and render juicy, a vegetable, as lettuce, celery, &c. he binds the leaves together, so that the light may have as little access as possible to their surfaces. In like manner, if we wish to etiolate men and women, we have only to congregate them in cities, where they are pretty securely kept out of the sun, and where they become as white, tender, and watery, as the finest celery. For the more exquisite specimens of this human etiolation, we must survey the inhabitants of mines, dungeons, and other subterraneous abodes; and for complete contrasts to these, we have only to examine the complexions of stage-coachmen, shepherds, and the sailor 'on the high and giddy mast.'" (Dr. James Johnson, *Change of Air*, p. 7, 4th ed. 1838).

As in bright solar light we feel more active, cheerful, and happy,—while obscurity and darkness give rise to a gloomy and depressed condition of mind,—so we employ insolation in the open air as a mental stimulus in melancholy, lowness of spirits, and despondency.

In amaurosis, supposed to depend on, or be connected with, a languid condition of the vital actions going on in the tunics of the eye, exposure to strong solar light (concentrated by a lens) has been proposed as a remedy. But notwithstanding that Hufeland[g] reports a case said to have been cured by it, its value is exceedingly doubtful, and its use requires extreme caution.

a. Darkness.

In many maladies light acts injuriously on the system, and its exclusion is attended with benefit to the patient.

In all diseases of the eye attended with local vascular or nervous excitement, darkness or obscurity should be employed. In inflammatory conditions of the brain, in fever, and in mental irritation, whether attended or not with vascular excitement, the stimulus of light proves injurious, and in such darkness of the chamber should be enjoined. After parturition, severe wounds, and surgical operations, and in all inflammatory conditions, the exclusion of light contributes to the well-doing of the patient. Lastly, darkness is employed to promote sleep[h]. In most cases where obscurity is indicated, rest and quietude are to be enjoined.

b. Dioptric Instruments.

When vision is imperfect, from defect of focal distance, the remedy consists in the use of dioptric or refracting instruments (*eye-glasses; spectacles*). In *Myopia* (i. e. *Short-* or *Near-sightedness*), doubly concave lenses (whose focal lengths vary from about 2½ to 48 inches) are usually employed to counteract the over refractive power of the humors; while, in *Presbyopia* (*Long-* or *Far-sightedness*), doubly convex lenses (whose focal lengths vary from about 6 to 48 inches) are generally used to obviate the diminished refractive power of the humors of the eye[i]. Lenses, for the above purposes, are commonly made either of flint-glass or of Brazilian quartz[k]. The latter, called *pebble*, has the advantage of greater hardness, and its surface, therefore, is not so readily scratched[l]. The diathermancy of quartz is about the same as that of mirror-glass[m].

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[f] *Op. supra cit.* p. 401.

[g] Quoted by Sundelin, *Handbuch der speciellen Heilmittellehre*, Bd. ii. S. 72. 3tte. Aufl. 1833.

[h] See p. 3.

[i] In opticians' shops two *trial boxes*, or *frames of sight*, are kept; the one comprises the range of doubly convex—the other, of the doubly concave lenses. These are used for trying myopic or presbyopic eyes.

Occasionally lenses of other forms, than those above enumerated, are employed; but the only one deserving of special notice is the *periscopic* or *meniscus* (concavo-convex) lens, recommended by Dr. Wollaston[n] for enlarging the field of vision[o].

c. CHROMATIC INSTRUMENTS.

In some affections of the eye (popularly known as *weakness of sight*), coloured glasses are employed, with occasional relief, to diminish the intensity of the light. Those with a neutral tint (or twilight tinge) prove the most agreeable to the eye.

White light is most fatiguing and hurtful to the eye[p]. The disease, called snow-blindness, which sometimes results from the long contemplation of a country covered with snow, is probably retinitis[q]. Both *red* and *yellow*[r] light are injurious to the eye. To the excess of the yellow and red rays, in common artificial light, may be in part ascribed the baneful influence of this light in causing impaired vision. Two modes of preventing its ill effects have been suggested; viz. the addition, by reflection, of the blue rays that are deficient (as by the use of conical blue shades or reflectors around the flame), or the subtraction, by absorption, of the red or yellow rays that are in excess (as by passing the light through some transparent medium of a blue tint)[s]. *Green*, *blue*, *indigo*, and *violet* lights, are much less injurious than either red or yellow. Spectacles of these colours have been made for the use of those suffering with sensitive eyes, but they are inferior to the neutral tint before mentioned, since after their removal from the eyes every object sometimes presents for a short period complimentary tints; showing that these colours have fatigued the retinæ. All dark-coloured glasses, however, and especially black crape spectacles, are objectionable, on account of their greater power of absorbing and radiating caloric, by which they prove heating to the eyes[t].

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[k] Quartz presents some remarkable optical phenomena. It possesses the property of double refraction in the direction of its axis. In this it differs from every other known uniaxial crystal. Moreover, when a plane-polarized ray is transmitted through a prism of quartz, the two pencils, into which the ray is divided, are, at their emergence, elliptically polarized (Airy, in *The Transactions of the Cambridge Philosophical Society*, vol. iv. 1833).

[l] Lenses made of amber are readily scratched and soon lose their polish.

[m] Melloni, *Taylor's Scientific Memoirs*, vol. i. p. 1. The transcalency or diathermancy of several transparent solids is as follows:—Of 100 rays of heat proceeding from the flame of an Argand lamp, there were transmitted by

	Rays transmitted.		*Rays transmitted.*
Rock Salt	92	Mirror Glass	62
Iceland Spar	62	Alum	12
Quartz	62	Sulphate of Copper (diaphanous)	0

In another series of experiments Melloni ascertained the relative diathermancy of Flint-Glass, Mirror (Plate) Glass, and Crown-Glass, to be respectively 65, 62, and 49.

[n] *Nicholson's Journal*, vols. vii. & viii.

[o] For further information respecting spectacles, consult Mackenzie's *Practical Treatise on Diseases of the Eye*, 3d edit, London, 1840, pp. 784 & 792; Kitchener's *Economy of the Eyes*, Part I. (Spectacles), London, 1824; and Cox's *Spectacle Secrets*, London, 1838.

[p] The intense light caused by the ignition of charcoal and the combustion of the metals effected by the Voltaic Battery constructed by Professor Groves, has produced on myself, as well as on some friends, temporary blindness. The symptoms (which lasted two days in my case) were those of retinitis, with profuse lachrymation.

[q] Mackenzie, *op. supra cit.* p. 501.—Xenophon (*Anabasis*, lib. iv.) speaks of snow-blindness.

[r] Hence amber lenses are objectionable.

[s] See Dr. James Hunter's work, *On the Influence of Artificial Light in causing Impaired Vision*. Edinburgh, 1840.

[t] Melloni (*op. supra cit.*) ascertained the diathermanous properties of coloured glasses to be as follows:—Of 100 incident rays, there are transmitted by

Coloured glass.	*Rays transmitted.*	*Coloured glass.*	*Rays transmitted.*
Deep violet	53	Bright yellow	34
Vivid red	47	Mineral green	23
Clear blue	42	Very deep blue	19

2. CALOR.—HEAT.

PHYSIOLOGICAL EFFECTS.—All living beings, but especially the animals denominated *warm-blooded*, generate heat. To all a certain temperature (which differs in different individuals) is essential to the maintenance of life; and hence caloric or heat is a vital stimulus[u]. Increased beyond a certain degree, it ceases to be vivifying: it may cause inflammation or apoplexy; it may exhaust by its prolonged stimulant operation; or, when its action is very violent, it may decompose the organized tissues by its chemical influence.

There are three modes of promoting or raising the temperature of warm-blooded animals, viz.:—

1. The communication from without of sensible heat, either by the application of heated substances to the body, or by the introduction of radiant heat.
2. By augmenting the generation of heat within the body; as by the use of stimulant foods and drinks.
3. By diminishing the cooling influence of surrounding bodies; as by the use of clothing made of substances which are bad conductors of caloric.

The effects of caloric communicated from without, on living beings, are threefold, viz.:—

1. PHYSICAL; including *expansion* or *dilatation*, and *fluidity*.
2. CHEMICAL; comprising *increased tendency to changes of composition* and *decomposition*.
3. DYNAMICAL, PHYSIOLOGICAL, OR VITAL; comprehending all *changes in the condition of the vital properties* produced by heat. These changes are of two kinds:—
    - α. *Primary;* excitement, or augmentation, of vital action.
    - β. *Secondary;* exhaustion, or diminution, of vital action.

a. On Vegetables.—A certain degree of heat promotes all the vital processes of plants. It accelerates germination, the growth and development of all vegetable organs, inflorescence, fecundation, and the ripening of the fruit; and it quickens the movements of parts susceptible of motion. Too elevated a temperature, accompanied with dryness, deranges the health of plants[x]. An intense heat decomposes the vegetable tissues.

b. On Man and other Animals.—A certain degree of external heat (different in different beings) promotes the vital manifestations of animals, and hence we denominate it an excitant or stimulant. Its prolonged operation, however, is followed by debility and exhaustion proportionate to the previous excitement.

The influence of tropical heat on the human species furnishes an illustrative example of the effects just mentioned. It is well known that the mental powers of children are sooner developed, and the sexes arrive earlier at puberty, in warm than in cold countries. Moreover, the languor, indolence, and relaxed fibres, so commonly observed in the inhabitants of tropical climates, are probably to be ascribed, in a great measure, to the exhausting and enervating influence of external heat.

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[u] See foot-note at p. 5.

[x] Decandolle, *Physiologie Végétale*, tom. iii. p. 1098.

The effects of topical heat are, first, a sensation of warmth, redness, turgescence, and a slight augmentation of temperature of the part heated. The diameters of the minute capillary vessels expand under the influence of caloric, and thus the red blood-disks are enabled to enter tubes previously impervious to them. The augmented volume of the part arises, therefore, in a great measure from the presence of an increased quantity of blood; but in part also from the dilatation of the solids and fluids caused by their augmented temperature. The living tissues become more relaxed, soft, and flexible, under the influence of a moderate heat, and admit of a more rapid transpiration.

A more violent degree of heat causes burning pain, redness, and vesication. A still more intense heat destroys vitality and organization. Whenever a large portion of the surface of the body is destroyed (as in burns and scalds), great constitutional disturbance, or even death, results from the shock given to the nervous system.

If the whole body be subjected to an elevated temperature, not incompatible with prolonged life, its effects are manifested first in the vascular system, and in the organs connected therewith. The superficial vessels enlarge; the skin becomes redder; and the pulse quicker and fuller: respiration is more frequent; the animal heat is augmented; and the expired air is hotter, and more loaded with vapour.

The exciting influence of heat, on the vascular system, points out the impropriety of employing this agent in inflammation or congestion of the organs (heart and lungs) engaged in the circulation of the blood; in dilatations of the heart; in aneurism; in apoplexy; and many other cases which will readily suggest themselves.

Increased exhalation (first of insensible and vaporous matter, then of visible and liquid sweat) and augmented secretion of the periphery soon succeed. The rapid conversion of a liquid into an aeriform fluid (insensible perspiration) is attended with the production of cold; and thus animals are enabled to counteract external heat, and to maintain nearly their original temperature, when exposed to a temperature considerably higher than that of their own bodies, by the increased perspiration which they suffer under these circumstances. The determination to the surface, and the increased transpiration and secretion of the skin, are attended with a contemporaneous diminution of activity in some of the internal organs. Thus, the secretions of the kidneys and the mucous membranes are diminished in consequence of the increased secretion and exhalation of the skin.

The mutually antagonizing influence of determinations of blood to different parts—as well as of the secretions of different tissues—is a circumstance the knowledge of which is of great practical value in therapeutics[y]. We avail ourselves of this influence, and employ external heat to produce determination of blood to, and augmented secretion of, the skin on various occasions; as when an internal malady is attended with coldness of surface, or appears to be connected with the sudden disappearance of a cutaneous eruption. The benefit obtained by the use of external heat in gastritis, enteritis, cystitis, and nephritis, is in part referrible to the same antagonising influence. External heat is also an important adjuvant in the treatment of diabetes: it checks the excessive secretion of urine, and relieves the dry and unperspirable state of the skin. Whenever we exhibit sudorific medicines, we promote their operation by keeping the surface warm; while when we employ diuretics, the skin should be kept cool. The agency of tropical heat in weakening the digestive organs, and the efficacy of spices, taken as condiments, in counteracting this effect, are clearly referrible to the principle of antagonism above explained.

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[y] See some valuable remarks on the "*antagonism*" of the secretions, in Müller's *Elements of Physiology*, by Dr. Baly, vol. i. p. 473.

The augmented secretion of bile, and the tendency to hepatic diseases, so commonly observed in Europeans when they become residents in warm climates, are other effects of the continued operation of heat on the body.

That heat, aided by inactivity, abundance of solid food, and little or no drink, is capable of inducing hepatic disease, is well shown on the goose. The celebrated *pâtés de foies gras*, prepared at Strasburg and Metz, are made from the livers of geese artificially enlarged. These animals are crammed with food, kept from drink, nailed to a plank by the webs of their feet, and placed quite close to a fire: and, in due time, their livers become greatly enlarged.

Relaxation of the living tissues is another consequence of the employment of moderate heat. This effect, which is best observed when moisture is conjoined with caloric, commences first in the part to which heat is applied: and, when the whole surface of the body has been subjected to an increased temperature, its relaxing influence soon extends to internal parts: hence arise atony, diminution of muscular power, a feeling of languor or fatigue, and an indisposition to corporal exertion.

We take advantage of this relaxing influence of heat in the treatment of spasmodic diseases, in the reduction of dislocations, in the application of the taxis in hernia, and on many other occasions where our object is to relax or soften muscular or other tissues. On the other hand, we avoid the employment of heat where preternatural relaxation or atony of the general system, but especially of the surface, exists.

The primary effect of moderate heat on the nervous system is excitation; the secondary effect, exhaustion. In the first instance sensibility is agreeably promoted, the action of the voluntary muscles assisted, and the intellect somewhat exalted. But to these effects succeed languor, relaxation, listlessness, indisposition to corporal and mental labour, and tendency to sleep.

Lastly, the prevailing maladies of hot climates may be referred to as farther illustrations of the effect of continued heat on the body. Fevers, diarrhœa, dysentery, cholera, and liver diseases, may be regarded as the special maladies of the burning equatorial regions.

The exhaustion, which follows the excitation caused by heat and other stimuli, would seem, to use the words of Müller[z], to "show that the organic force is consumed, as it were, by the exercise of the functions;" and to employ a simile of Dr. Priestley[a], we may say, that as a candle burns out much faster in oxygen gas than in air, so we may be said to live out too fast when under the exciting influence of an elevated temperature.

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[z] *Op. cit.* vol. i. p. 52.
[a] *Experiments and Observations on different kinds of Air*, vol. ii. p. 169. Birmingham, 1790.

USES.—Heat is employed as a remedial agent for various purposes, of which the following are the principal:—

1. To cause an afflux of blood to a part; by which,—
    - *a.* Healthy circulation and temperature may be restored.
    - *b.* The equalization of the distribution of blood may be effected; and thereby a preternatural afflux to other organs checked.
    - *c.* The secretions and exhalations of a part may be re-established or increased.
2. To promote the general circulation of blood.
3. To relax tense, rigid, or spasmodically contracted tissues.
4. To alleviate pain.
5. To hasten organic changes; as the termination (resolution or suppuration) of inflammation.
6. To destroy the vitality and organization of a part.

The most important circumstances which contra-indicate its employment, are—

1. Great vascular excitement, plethora, aneurism, hemorrhage, &c.
2. Great relaxation and flabbiness, especially in the superficial organs.
3. Profuse secretion and exhalation.
4. Great nervous excitability, with little power.

Heat is communicated to the body in two ways; viz. by *radiation* and by *conduction.*

a. RADIANT HEAT.

Radiant heat proceeds from the sun and terrestrial bodies, in straight lines or rays. Therapeutically it has been employed as a stimulant or excitant, to promote circulation and warmth in the old, the debilitated, and the paralytic; and as a cautery.

a. SOLAR HEAT.—The rays, which proceed from the sun, are of three kinds—illuminating, heat-making, and chemical. Their important influence—as illuminating rays—have been already alluded to[b].

The ancients[c] were well acquainted with the salutary influence of solar heat on the human frame, and frequently employed it for therapeutical purposes.

Insolation (*insolatio, apricatio, solicatio, heliosis,* ἡλίωσις) may be employed as a stimulant for the purposes already mentioned. It is also valuable in scrofula, and as a restorative after lingering and painful maladies. Whenever it is used the head should be carefully guarded from the direct influence of the sun, in order to prevent the occurrence of the *sun-stroke,* or *ictus solaris,* before referred to[d]. Occasionally erythema or erysipelas is produced by the direct action of the sun on the naked skin.

Faure concentrated the solar rays by a burning-glass, and employed them to stimulate indolent ulcers, especially those which follow frost-bites. Formerly cauterization was effected in the same way[e].

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[b] See p. 5.

[c] Hippocrates, *De Morbis,* lib. ii. 66 & 68; Celsus, lib. i. cap. 2 & 3; Cælius Aurelianus, *Morb. Chronic.* lib. iv. cap. 2.

[d] Page 5.

[e] Marjolin, in *Dict. de Médecine,* art. *Cautérisation.* Most, in his *Encyklopädie der gesammten medicin. u. chirurg. Praxis,* Leipzig, 1837, art. *Insolatio,* quotes two authors on insolation, whom I have had no opportunity of consulting: they are Dresig, *De solicatione, vulgo insolatione veterum,* Lips. 1737; and Richter, *Diss. Insolatio, seu potestas solis in corpus humanum,* Götting. 1747.

2. *Artificial Radiant Heat.*—Exposure to the rays of a common fire is resorted to, as a stimulant and calefacient, in old paralytic and other cases attended with coldness and blueness of the extremities, and other symptoms of insufficient circulation of the blood.

The heat radiating from a burning body (as a candle), or ignited iron, is sometimes employed as a stimulant to produce rubefaction in the tract of the vertebral column, in paralytic and neuralgic affections of the spinal cord. "A much more durable impression of heat," observes Müller[f], "better than moxa or the actual cautery, is produced by holding a burning candle near to the affected part for a long time, so as to produce pain; by which means all the beneficial effect of heat is obtained, without the formation of an eschar and the subsequent suppuration, which is often of no service. The mode in which the caloric acts in these cases is not evident."

The radiant heat from a red-hot iron or burning coal has been employed as a cautery to check hemorrhages, and to promote the reduction of prolapsus of the rectum and uterus, and of hernia. This practice constitutes the *cautérisation objective* of the French writers.

β. *Conducted Heat.*

1. *Calor siccus.—Dry Heat.*

This includes hot air, bottles filled with hot water, hot sand, &c.

1. *Hot-Air Bath.*—Air, at a temperature of from 100° to 130° F., is a powerful stimulant and calefacient, but is less relaxing and soothing than moist vapour. When required to operate as a sudorific, a temperature of from 90° to 100° F. (Dr. Gower says 85°) is found most advantageous. The hot air bath is principally valuable as a remedial agent when the blood has receded from the superficial parts of the body, and the internal organs are in a state of congestion; as in some forms of fever, and in spasmodic cholera. In asphyxia from drowning, and from some other causes, it is also highly useful. Furthermore, in chronic rheumatism, stiffness of the joints, and chronic skin diseases (especially the dry scaly eruptions), it also proves beneficial[g].

The *medicated hot-air bath* is prepared by impregnating the hot air with some gas or vapour; as with sulphurous acid gas or chlorine[h].

2. *Solid Substances, heated not beyond* 100°.—*Bottles filled with hot water* are applied to the feet to excite the circulation and augment the animal heat, in various diseases attended with cold extremities. The same remedy is conveniently applied to the abdomen, to relieve spasmodic pain. *Hot sand* (*arena calida*), enclosed

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[f] *Op. cit.* vol. i. p. 59.

[g] For farther information respecting the hot-air bath, consult the *Cyclopædia of Practical Medicine*, vol. i. p. 266. art. *Warm-Air Bath*, by Dr. Forbes.—Also Dr. Gower's *Auxiliaries to Medicine*, Lond. 1819, Tract 1, *An Account of the Sudatorium.*

Various simple and ready modes of making a hot-air bath have been suggested. A very simple method is that recommended by Mr. Alcock (*Lancet*, 1825-6, vol. ix. p. 862). It consists in burning spirit in a cup or saucer under a blanket; the patient lying on the bed with his head and face outside the blanket, as the air is not fit for respiration. The blanket is supported over the bed by a cord.

[h] See *Chlorine* and *Sulphurous Acid.*

in a bag or bladder, may be employed for similar purposes. Sometimes hot sand is used as a bath[i]. It is rarely resorted to in this country, but is had recourse to in the maritime departments of the South of France[j]. A sand-bath operates as a stimulant and sudorific; and is employed in rheumatism, spasm, paralysis, &c.[k] *Hot ashes* or *bran* have been applied to similar uses; as also *hot bricks*. *The leaves of the common birch* (*Betula alba*) are employed in Sweden[l].

3. *Metal heated to* 212°.—The late Sir Anthony Carlisle[m] proposed to excite speedy vesication by the application to the skin of a polished plate of metal, heated to 212° by immersion in boiling water. He recommended it as a substitute for cantharides, than which he declared it to be less painful. Moreover, it is not liable to cause strangury.

4. *The Actual Cautery* (*Cauterium actuale*).—The term *actual cautery* is used to indicate a heated substance, employed to burn or disorganize a portion of the living body, to which it is applied.

A *potential cautery* disorganizes by its affinity for the constituents of the living tissues.

Several agents have been employed as actual cauteries, viz. *red-hot iron*, *moxa*, and the *flame of hydrogen*. The first, however, is the one generally used, and commonly meant, when we speak of the actual cautery. The two latter will be noticed in subsequent parts of the work[n].

I have excluded *boiling water*, *steam*, and *metal heated to* 212°, from the list of cauteries. These agents coagulate and harden the albuminous and fibrinous portions of the living tissues, and excite acute inflammation; that is, they *scald*. They neither decompose nor effect any chemical change in the organic principles; and, therefore, chemically speaking, they do not *burn* the living tissues.

In this country the actual cautery (red-hot iron) is seldom used. It is sometimes resorted to as a styptic, where the hemorrhage is from a great number of small vessels, or from a vessel so situated that the ligature cannot be applied. It is also used to destroy morbid growths, which cannot be reached by the knife—as fungus of the antrum. Lastly, it has been applied to stop caries, to excite an artificial ulcer, to open abscesses, to close fistulous ulcers, in bites by poisonous animals, and in some affections of the brain—as epilepsy, to destroy the part from whence the aura epileptica sets out[o].

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[i] The phrase *balneum arenæ* is incorrect. Celsus (lib. ii. cap. 17) limits the term *balneum* to a water-bath artificially heated in a private house.

[j] Schwilgue, *Traité de Matière Médicale*, t. ii. p. 324.

[k] The therapeutical use of sand is denominated *arenatio* or *psammismus* (ψσαμμισμὸς, from ψσάμμος, *sand*). See Quiring, *De balneis arte parandis. Diss. Inaug.* Berol. 1837.—" *Saburration* was a species of bathing in ancient use. The body was buried in sand, and exposed to the sun" (Sutherland's *Attempts to revive Antient Medical Doctrines*, vol. i. p. 48. Lond. 1763).—Sand is employed therapeutically for other purposes than to communicate heat. Thus, a bag of sand has been applied to the abdomen, to compress, by its weight, the uterus, and thereby to restrain uterine hæmorrhage after the removal of the placenta; but incomplete inversion of the uterus is said to have been produced by it (see Most, *Encyklopädie der gesammt. med. u. chir. Praxis*, Bd. i. S. 175. Leipzig, 1836). Sand has also been used as a mechanical support in fractures of the leg.

[l] Bergius, *Materia Medica*, t. ii. 778, ed. 2nda, Stockh. 1782.

[m] *Lancet*, 1826-27, vol. xi. p. 315 & 384.

[n] See *Hydrogen*, and *Artemisia Moxa*.

[o] For further details respecting the actual cautery and cauterization, I must refer the reader to Percy's *Pyrotechnie chirurgicale pratique*, Paris, 1811; Marjolin, art. *Cautère* and *Cautérization*, in the *Dict. de Médecine*; and Sanson, in the *Dict. de Méd. et Chir. pratiques*.

2. *Calor humidus.—Moist Heat.*

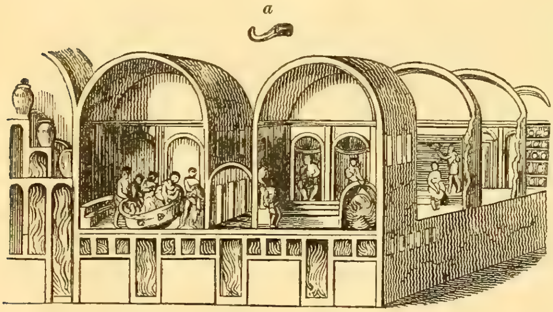
a. AQUEOUS VAPOUR.

The practice of bathing is of great antiquity, and precedes the date of our earliest records. It was adopted sometimes for the purpose of cleanliness, sometimes for the preservation of health, and frequently as a recreation and luxury. The ancient Hebrews[p] practised ablutions. Josephus[q] mentions that Herod was let down into a bath of oil. The Greeks employed bathing. Homer[r], on various occasions, mentions hot baths and ablutions. In the writings ascribed to Hippocrates[s], baths are mentioned, and their effects described. Baths are also noticed by Celsus[t], Pliny[u], and other Roman writers. Prosper Alpinus[v] says, that the Egyptians employed hot baths for cleanliness and health; and Freind states, that when Alexandria was plundered, in A.D. 640, there were 4000 baths in that city[w]. Among the Persians, baths were in use[x]. The Arabians also were acquainted with hot baths, as we learn from Avicenna[y]. The ancient Hindoos employed baths and aspersions with water[z].

These examples sufficiently establish the great antiquity of the practice of bathing[a].

The following is a sketch of the baths of the Romans, copied from a painting found at the *Thermæ* of Titus[b].

Fig. 1.



Ancient Baths.

a. The *Strigil* (a scraper or currycomb, used at baths to scrape the skin).

On the right is the *eleotherium* (ἀλειπτήριον) where the oils and perfumes are kept in vases: next to this is the *frigidarium* (ἀποδυτήριον) or dressing-room: the third apartment is the *tepidarium*: the fourth is the sudatory (*concamerata sudatio*), in which are seen the *laconicum* (so called from being first used in Laconia), a brazen furnace to heat the room, and persons sitting on the steps: the fifth is the *balneum*, with its huge basin (*labrum*), supplied by pipes, communicating with three large bronze vases, called *milliaria*, from their capaciousness; the lower one contained hot, the upper one cold, and the middle one tepid water. The bathers returned back to the frigidarium, which sometimes contained a cold bath. The subterranean portion of the building, where the fires were placed for heating the baths, was called the *hypocaustum*.

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[p] *Leviticus*, xiv. 8.—2 *Kings*, v. 10.

[q] *Bell. Jud.* lib. i. cap. 33, § 5.

[r] *Iliad*, xxii. 444. *Odyss.* viii. 451.—It would appear from Homer, that the offices of the baths were performed by females; though, from a passage in Herodotus (*Erato*, xix.), we may infer that this custom was not peculiar to the Greeks.

[s] *De diæta*, lib. ii. § 35. *De affectionibus*, § 47.

[t] Lib. i. cap. 3; and lib. ii. cap. 17.

[u] *Hist. Nat.* lib. xxix. cap. 8; lib. xxxi. cap. 2, et seq. Ed. Valp.

[v] *Medicina Ægyptiorum*, lib. iii. cap. 14—19.

[w] *History of Physick*, part i. p. 7. 3d ed. Lond. 1727.

[x] Xenophon, *Cyropædia*, lib. viii.—Plutarch, in his life of Alexander the Great, mentions that this celebrated conqueror was astonished at the sight of the baths of Darius.

[y] *Canon*, lib. iii. fen. xvi. tract. iv. cap. 10.

[z] Royle's *Essay on the Antiquity of Hindoo Medicine*, p. 53. Lond. 1837.

[a] For further information respecting ancient baths, consult *An Account of the Ancient Baths, and their Use in Physic*, by Thos. Glass, M.D. Lond. 1752.—*Attempts to revive Antient Medical Doctrines*, by Alexander Sutherland, M.D. Vol. i. p. 12, et seq. Lond. 1763.—Also, *De Balneis omnia quæ extant apud Græcos, Latinos et Arabas.* Venet. 1553.

[b] De Montfaucon, *L'Antiquité expliquée et representée en Figures*, tom. iii. part. ii. p. 204, 2nde éd. Paris, 1722.

1. *The Vapour Bath.*—As aqueous vapour, like air, is a worse conductor of caloric than liquid water, its influence, as a source of either heat or cold, is neither so powerfully nor so speedily felt as that of the latter. Hence, therefore, the temperature of the vapour bath should always exceed that of the water bath. If, however, the whole body be immersed in vapour, which is consequently inhaled, the temperature must be a little less than if the trunk and limbs alone were subjected to the influence of vapour; because the inhalation of vapour stops the cooling process of evaporation from the lungs. The following is a comparative view of the heating powers of water and of vapour, distinguishing the latter according as it is or is not breathed[c].

	Water.	*Vapour.*	
		Not breathed.	Breathed.
Tepid bath	85° — 92°	96° — 106°	90° — 100°
Warm bath	92° — 98°	106° — 120°	100° — 110°
Hot bath	98° — 106°	120° — 160°	110° — 130°

The general effects of the vapour bath are those of a powerful stimulant and sudorific. It softens and relaxes the cutaneous tissue, expands the superficial vessels, accelerates the circulation of blood, augments the frequency of the pulse and respiration, and produces copious perspiration. These effects are succeeded by a feeling of languor and a tendency to sleep.

The vapour bath is distinguished from the hot-air bath by its soothing, relaxing, and greater sudorific influence; from the hot-water bath, by its inferior power of communicating heat, by its greater sudorific tendency, and by its causing scarcely any superficial compression of the body, whereby it does not occasion the præcordial oppression experienced on entering the water bath.

The vapour bath, like the hot-air bath, may be employed when the blood has receded from superficial parts, and congestion of internal organs has in consequence occurred;—as during the cold stage of intermittent fever, in malignant cholera, and during the stage of chilliness which ushers in various febrile complaints. But its great value is experienced when our object is to relax the skin, and to produce profuse sweating. Thus in chronic rheumatism and gout, in slight colds from checked perspiration, and in chronic skin diseases, accompanied with a dry state of the cutaneous surface, it often proves highly serviceable. In old paralytic cases, unaccompanied with signs of vascular excitement of the brain, it sometimes gives relief. In some uterine affections, as chlorosis, amenorrhœa, and irritation of the womb; in dropsy of old debilitated subjects; in old liver complaints; and in some scrofulous affections, the vapour bath is occasionally employed with advantage[d].

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[c] Dr. Forbes, *Cyclopædia of Practical Medicine*, art. *Bathing*, vol. i. p. 265.

In this country the vapour bath is employed for therapeutic purposes only. In Egypt, Turkey, Persia, and some other parts of the East, and in Russia, however, it is in common use as a hygienic agent and luxury; and is accompanied by a process of friction, kneading, and extension of the muscles, tendons, and ligaments, constituting the *massing*[e] of the Egyptians, and the *shampooing*[f] of the East Indians. This process is thus described by Dr. Gibney[g]:—"After exposure to the bath, while the body is yet warm from the effects of the vapour, the shampooman proceeds, according to the circumstances of the case, from gentle friction gradually increased to pressure, along the fleshy and tendinous parts of the limb;—he kneads and grasps the muscle repeatedly, presses with the points of his fingers along its course, and then follows friction, in a greater or less degree, alternating one with the other, while the hand is smeared with a medicated oil, in the specific influence of which the operator has considerable confidence. This process is continued for a shorter or longer space of time, and, according to circumstances, is either succeeded or preceded by an extension of the capsular ligament of each joint, from the larger to the smaller, causing each to crack, so as to be distinctly heard, which also succeeds from the process being extended to each connecting ligament of the vertebræ of the back and loins. The sensation at the moment is far from agreeable, but is succeeded by effects not dissimilar to what arise from brisk electrical sparks, taken from the joints in quick succession."

In rigidity and stiffness of joints this process of massing or shampooing may prove of considerable service.

The *Russian Vapour Baths* have long been celebrated. The vapour is produced by throwing water over red-hot stones. Its temperature, according to Lyall[h], is from 122° to 144·5° F. Besides being exposed to the influence of this vapour, the bathers are subjected to a system of friction, flogging with the leafy branches of the birch, and affusions of warm or cold water. It is customary with them to issue from the bathing-houses while quite hot, and, in the summer, to plunge into cold water,—in the winter, to roll themselves naked in the snow, without sustaining injury or ever catching cold[i]. Bremner[k] describes the supposed bracing effects as being all imaginary; and declares that the practice of bathing, followed by the Russians, rapidly enervates and undermines the constitution. Several medical writers[l] have borne testimony to the efficacy of the baths in alleviating rheumatism.

The *Egyptian Vapour Baths* are in constant and general use. The bathers having been subjected to the operation of *massing*, already described, are then rubbed, and afterwards washed[m]. The *Turkish*[n] as well as the *Persian*[o] *Baths* are somewhat similar.

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[d] For a more detailed account of the uses of the vapour bath, the reader is referred to Dr. Gibney's *Treatise on the Properties and Medical Application of the Vapour Bath*. Lond 1825.

[e] *Masser*, from the Arabic verb *masses*, to touch lightly. See Savary's *Letters on Egypt*, vol. i. p. 130, 2d ed. Lond. 1787.

[f] Mahomed's *Treatise on Shampooing*.—I have not met with this work.

[g] *Op. supra cit.* p. 84.

[h] *Character of the Russians*, p. 112, Lond. 1823.—Mr. Lyall has given a plan of the Russian baths.

[i] Dr. E. D. Clarke's *Travels in various Countries of Europe*, part i. p. 143, et seq.

[k] *Excursions in the Interior of Russia*, vol. i. p. 185. Lond. 1839.

[l] Dr. Granville's *St. Petersburgh*, vol. i. p. 509. Lond. 1828.

Topical or *local vapour baths* are sometimes employed in the treatment of local diseases, as affections of the joints. Dr. Macartney[p] recommends the topical use of vapour, as a soothing and anodyne application, in painful wounds, contusions, and fractures, and has invented an apparatus for generating and applying it, which is sold by Mr. Stoddart, 401, Strand, London.

The *vapour douche* may be regarded as a topical vapour bath. It is a jet of aqueous vapour (whose temperature does not exceed that of a general vapour bath) directed on some part of the body, and its action depends principally on the temperature of the fluid; for its mechanical effects are comparatively trifling. In some affections of the ear, as otitis, otorrhœa, and otalgia, a stream of warm aqueous vapour is sometimes introduced into the meatus auditorius externus with considerable relief; and the most ready means of effecting it is by a funnel inverted over a vessel of hot water, the meatus being applied to the orifice of the funnel.

The *medicated vapour bath* is prepared by impregnating aqueous vapour with the odour of medicinal plants. There is no good reason, however, for supposing that it possesses any advantage over the simple vapour bath.

Sulphur vapour, *sulphurous acid gas*, *chlorine gas*, and *the vapour of camphor*, are sometimes employed in conjunction with aqueous vapour. Their effects will be described hereafter.

The application of vapour to particular parts of the body has been accompanied with the simultaneous removal of atmospheric pressure, constituting the *air-pump vapour bath*. It has been employed in gout, rheumatism, and paralysis[q].

2. *INHALATION OF WARM VAPOUR.*—The inhalation of warm aqueous vapour proves highly serviceable, as an emollient remedy, in irritation or inflammation of the tonsils, or of the membrane lining the larynx, trachea, or bronchial tubes. It may be employed by Mudge's inhaler, or by inspiring the vapour arising from warm water. Various narcotic and emollient substances are frequently added to the water, but without adding much (if any thing) to its therapeutical power. Dr. Paris[r] states that, in some pulmonary complaints, he has been long in the habit of recommending persons confined in artificially-warmed apartments to evaporate a certain portion of water, whenever the external air has become excessively dry by the preva-

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[m] For a description and representation of the Egyptian baths, consult *Description de l'Egypte.* Etat Moderne, t. ii. (2de partie), p. 683. Vol. i. planche 49; and vol. ii. planche 94.—Also Lane's *Account of the Manners and Customs of the Modern Egyptians*, vol. ii. p. 35, Lond. 1837.—Sir J. G. Wilkinson, in his *Manners and Customs of the Ancient Egyptians*, vol. iii. p. 388, Lond. 1837, has given a sketch, from a painting in a tomb at Thebes, representing a lady in a bath, with four attendants.

[n] D'Ohsson's *Tableau Général de l'Empire Ottoman*, tom. i. p. 160, Paris, 1787.—An engraving of a bath is given.

[o] Fowler's *Three Years in Persia*, vol. i. p. 269, Lond. 1841.

[p] *A Treatise on Inflammation*, p. 176. Lond. 1838.

[q] *Facts and Observations respecting the Air-Pump Vapour Bath in Gout, Rheumatism, Palsy, and other Diseases.* By Ralph Blegborough, M.D. Lond. 1803.—La Beaume, *Observations on the Air-Pump Vapour-Bath.* Lond.

[r] *Pharmacologia*, vol. i. pp. 198 & 379, ed. 6th. Lond. 1825.

lence of the north-east winds, which so frequently infest this island during the months of spring; and the most marked advantage has attended the practice. In rooms artificially heated by hot-air stoves, the necessity for this proceeding is still more obvious.

The benefit which pulmonary invalids are said to have derived from a *residence in cow-houses*[s] is in part referrible to the moist warm air with which such places are filled, though something, perhaps, may be ascribed to the carbonic acid gas which is present[t].

3. *Steam.*—Steam (*i. e.* aqueous vapour heated at least to 212° F.) is sometimes employed as a powerful rubefacient and caustic. It contains more specific and latent heat than boiling water, but its conducting power is less. It is applied by a small copper or tin boiler (called an *eolipile*) furnished with a tubular mouth and stopcock, and heated by a spirit-lamp. Its action on the body is limited by a perforated piece of pasteboard. If applied sufficiently long, it causes an extensive and deep eschar. In this respect its action is similar to that of boiling water, from which it principally differs in the circumstance of having a much larger quantity of specific heat, and in the greater facility with which we can limit its effects. It greatly resembles moxa, but its action is less readily localized, and the wound which it causes is less manageable. It has been used as a powerful counter-irritant in diseases of the hip-joint, neuralgic pains, chronic rheumatism, &c. The objections to its employment are the great pain which it causes, and the danger of its effects.

b. Water.

Hot, but not scalding water, augments the temperature, volume, and redness of living parts, relaxes the tissues, and increases the vital actions.

1. *Tepid, Warm, and Hot Baths.*—*a.* The *Tepid Bath* has a temperature of from 85° to 92° F. It gives rise to a sensation of either heat or cold, according to the temperature of the body at the time of immersion. It cleanses the skin, promotes perspiration, and allays thirst. It is sometimes employed as a preparative to the tem-

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[s] See Dr. Beddoes's *Observations on the Medical and Domestic Management of the Consumptive, on the Digitalis purpurea, and on the Cure of Scrophula.* Lond. 1801.

[t] See Vogt's *Lehrbuch der Pharmakodynamik,* 2er Band. S. 32; 2te Aufl. Giessen, 1828.—I am indebted to Mr. Steinhaeuser (a very intelligent pupil of mine), a native of Saxony, for the following note on residence in cow-houses, as a remedial agent in diseases of the lungs:—"In Germany the balsamic air of cow-sheds is commonly recommended as a preventive in suspected pulmonary disease, or as a means of prolonging life in a confirmed phthisis. Although this latter disease is comparatively of rare occurrence in Saxony, yet several cases have fallen under my own observation, in which this plan of treatment was adopted. The mode of effecting it has varied according to circumstances: in some cases the patient has merely retired from a crowded town to a farm-house; in others, the sitting and bed-rooms have actually been converted into residences for cows. Of the former I have known several instances where patients have been greatly benefited by sleeping in apartments built over cow-stalls; and this, I should say, is the most usual plan adopted. Of the latter I can only record one case, which is somewhat remarkable. It is that of the late Prince Putiati, a Russian exile, resident in the vicinity of Dresden, and well known there on account of his eccentricities. His young, beautiful, and only daughter, the Countess ———, being affected with this destructive malady (phthisis), to which she eventually fell a victim, the warm air of cow-sheds was recommended by her physicians, as a mode of prolonging her life. The Prince ordered the lower part of a wing of his magnificent but curiously-constructed mansion (Schachwitz) to be converted into a cow-stable; and the elegantly furnished sitting and sleeping apartments of his daughter were so arranged, that she was actually in the same room with the cattle, from which she was separated merely by a low partition."

perate, cool, or cold bath. When there is a tendency to apoplexy, the simultaneous immersion in the tepid bath, and affusion of cold water over the head, have been recommended.

b. The *Warm Bath* has a temperature of from 92° to 98° F.:—that is, about that of the body, or a little below it. In general it causes a sensation of warmth, which is more obvious when the body has been previously cooled. It renders the pulse fuller and more frequent, accelerates respiration, and augments perspiration. It causes languor, diminution of muscular power, faintness, and a tendency to sleep. As a relaxant, it is employed to assist reduction in dislocations of the larger joints, and in hernia. In the passage of calculi, whether urinary or biliary, it is used with the greatest advantage: it relaxes the ducts, and thereby alleviates the pain, and facilitates the passage of the concretion. In gastritis, enteritis, cystitis, and nephritis, it proves a valuable and powerful agent. In exanthematous diseases, when the eruption has receded from the skin, in chronic cutaneous diseases, rheumatism, amenorrhœa, and dysmenorrhœa, it is highly serviceable.

The *coxæluvium*, or *hip-bath*, is resorted to in inflammatory or spasmodic affections of the abdominal and pelvic viscera, and in amenorrhœa, and in dysmenorrhœa. It is also sometimes employed as a substitute for the general bath, where some affection of the lungs, heart, or great vessels, prohibits the use of the latter. The *bidet* is employed in piles, prolapsed rectum, strangury, ischuria, &c. The *pediluvium*, or *foot-bath*, is used as a revulsive or counter-irritant in slight colds; to promote the menstrual and hemorrhoidal discharges; and for various topical purposes. The *brachiluvium*, or *arm-bath*, and *manuluvium*, or *hand-bath*, are principally applied in topical affections of the upper extremities.

c. The Hot Bath has a temperature of from 98° to 112° F. It causes a sensation of heat, renders the pulse fuller and stronger, accelerates respiration, occasions intense redness of the skin, and subsequently copious perspiration; gives rise to violent throbbing, and a sensation of distension of the vessels of the head, with a feeling of suffocation and anxiety. Long immersion may cause apoplexy. Being a powerful excitant, its use requires considerable caution. It is principally employed in paralysis, rheumatism, and some other chronic diseases.

The above remarks apply to common or fresh water-baths. But *Sea Water*, *Mineral Waters*, and various *Medicated Waters*, are employed for general or topical baths. Of the medicated water-baths, those in most frequent use are the *nitro-muriatic*, the *ioduretted*, the *salt water*, the *alkaline*, and the *alkaline sulphuretted*. These will be described hereafter. A *decoction or infusion of bran*, and *a solution of bichloride of mercury*, are used as pediluvia. *Milk* and *gelatinous liquids* are employed as nourishing baths. *Blood*, and *the soft parts of recently killed animals*, were formerly used as baths [u].

Mud-bathing (*illutatio*, from *in*, upon; and *lutum*, mud) is a very ancient practice. The slime of the Nile was formerly in great request for this purpose [w].

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[u] See Quiring, *op. supra cit.*

[w] Aetii, *Serm*, i. cap 1 and 3.—Sunderland, *Attempts to revive Antient Medical Doctrines*, vol i. p. 45. Lond. 1763.

The saline mud found on the sea-shore has been employed, in very hot weather, as a bath, by the inhabitants of Crimea, and especially by the Tartars, against hypochondriasis, scurvy, scrofula, &c. It operates as an excitant and sudorific [x]. *Hot dung* is used in France, as a kind of bath against rheumatism, and in Poland against syphilis [y]. *The husk of the grape*, and *the refuse of the olive*, from which the oil has been drawn, undergo fermentation, and, in this state, have been successfully employed in Paris against acute rheumatism [z].

2. *Warm Affusion.*—Warm affusion excites very pleasant sensation, followed by chilliness, and often by pulmonary affections. It has, however, been used in mania. It reduces the frequency of the pulse and of respiration, and occasions a tendency to repose; but its effects are much more temporary than those of the warm bath [a].

3. *Warm Fomentations and Poultices.*—*Warm fomentations* are employed to relieve inflammation, pain, tension, and spasm. In inflammation of the abdominal and pelvic viscera, and in strangury, they are highly serviceable. My friend and colleague, Mr. Luke, has employed, for several years, warm water as an emollient application to burns and scalds, and his account of its effects is as follows:—“After several years' experience in the use of warm water as an application in the first treatment of scalds and burns admitted into the London Hospital, I am enabled to say, that the general result has been very satisfactory. It has, almost in every instance, appeared to soothe and mitigate pain; and, in many instances, to facilitate the recovery of the patient from the great constitutional depression so frequently attendant upon cases of severity. In these respects I think it exceeds in value all other means which I have seen used. It appears also to me to have exerted a beneficial influence in mitigating the consecutive inflammation, rendering the after consequences less severe locally, and the reparative process more speedy, than under other modes of treatment. The most striking exemplifications of its value have been seen in the treatment of the scalds and burns of young children, and of those cases where the vitality of the skin has not been completely destroyed. The water has generally been used in the form of fomentations; repeatedly changing the flannels, and taking care that the surface of the skin was exposed as little as possible. The occasional use of poultices has also been adopted, and with much benefit; although their weight, when large, has rendered them not so convenient as fomentations: they obviate, however, the evil arising from the frequent renewal of the latter, and the consequent mechanical irritation. Inability to continue the warm bath, for the requisite length of time, has been the reason for its not being used in these cases.”

Emollient poultices act as a kind of local bath. They are employed to relieve pain, spasm, and tension, and to promote the termination of inflammation by resolution or suppuration.

4. *Warm Aqueous Drinks and Injections.*—Tepid or warm water is *taken into the stomach* to promote vomiting; to dilute the

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[x] *Bull. des Sc. Méd. de Ferussac*, xiii. 179.
[y] Merat and De Lens, *Dict. de Mat. Méd.* art. *Bain.*
[z] Ibid.
[a] For further details respecting *Affusion*, see p. 27.

contents of the stomach, in cases of poisoning by acrid substances; to excite diaphoresis in rheumatism, catarrh, gout, &c.; and to allay troublesome cough, especially when dependent on irritation at the top of the larynx. Warm water is *injected into the rectum* to excite alvine evacuations; to promote the hemorrhoidal flux; to diminish irritation in the large intestine, or in some neighbouring organs, as the uterus, bladder, prostate gland, &c.; and to bring on the menstrual secretion. *Thrown into the vagina*, it is used to allay uterine irritation and pain, and to promote the lochial discharge. *Injected into the bladder*, it is sometimes employed to relieve vesical irritation, or to distend the bladder previously to the operation of lithotrity. It has also been *injected into the urethra* to allay pain, irritation, inflammation, and spasm.

Lastly, Magendie *injected warm water into the veins* in hydrophobia, but without saving the life of the patients. I have repeated the experiment, but without any successful result. The same remedy has been employed by Vernière[b] to distend the venous system, and thereby to check or stop absorption in cases of poisoning by those substances (opium, for example), which operate by getting into the blood. Moreover, warm water is sometimes used as a medium for the introduction of more powerful agents (as emetic tartar) into the circulating system.

5. *Boiling Water.*—Water at the temperature of 212° F. is a powerful irritant, vesicant, and cautery. Its effects are similar to those of steam before mentioned. It has been applied to the skin as a powerful counter-irritant in maladies of internal organs, and as a speedy vesicant when the object is to introduce medicinal substances (morphia, for example) into the system by the cutis vera. But the excessive pain which it gives rise to, the uncertainty of its effects, and the difficulty of localizing its action, are great and almost insuperable objections to its use.

Frigus.—Cold.

Physiological Effects.—The general effect of cold on living bodies is a diminution of vital activity; which terminates, if the cold be intense and its application continued, in death; but, if moderate and temporary, in increased activity of the vital powers, *i. e.* in reaction. Hence, then, we distinguish two orders of effects:—

1. The *direct, primary,* or *immediate.*
2. The *indirect, secondary,* or *mediate.*

In the warm-blooded animals there are two modes of checking or diminishing their temperature:—

1. The abstraction of caloric, by the application of cold substances to the body.
2. The diminution of the generation of heat within the body, by use of refrigerants or sedatives.

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[b] Christison's *Treatise on Poisons*, p. 35, 3d. ed., 1835.

The influence of cold is threefold:—

1. Physical; including *diminution of volume, of temperature*, and *of fluidity.*
2. Chemical; comprising *a diminished tendency to changes of composition*, and *to decomposition.*
3. Dynamical, Physiological, or Vital; comprehending *changes in the condition of the vital properties*, induced by cold. These changes are of two kinds:—
   - α. *Primary;* sedation, or a diminution of vital activity.
   - β. *Secondary;* reaction.

a. On Vegetables.—The effects of cold on plants are greater in proportion to the combined humidity. The first effect is a certain state of languor or torpor manifested in germination, the growth and development of all the vegetable organs, inflorescence, fecundation, and maturation of the fruit. Cold also favours the disarticulation of articulated parts. Lastly, by an intense frost the aqueous juices freeze,—an effect which is often attended with the death of part or the whole of a plant[c].

b. On Man, and other Animals.—The first effect of diminished temperature is that which we denominate a sensation of cold. Its intensity depends not merely on the actual degree of cold to which the living surface is exposed, but is in proportion to the conducting power of the cooling agent, as well as to the previous heat of the living surface.

"If, in winter, a person, with bare feet, were to step from the carpet to the wooden floor, from this to the hearth-stone, and from the stone to the steel-fender, his sensation would deem each of these in succession colder than the preceding. Now the truth being that all had the same temperature, only a temperature inferior to that of the living body, the best conductor, when in contact with the body, would carry off heat the fastest, and would, therefore, be deemed the coldest[d]."

A substance, having a temperature of 60° F., will feel warm to the hand or other living part previously exposed to a temperature of 32° F., but cold to a part which immediately before was exposed to a heat of 96° or 98° F.

The sensation of cold is soon followed by a reduction of temperature and a diminution of volume of the part. This last effect is partly physical, partly vital. Of course the solids and fluids of the body, in common with inorganized substances, must have their bulk reduced when their temperature is diminished. But a living part lessens in size from a vital manifestation—viz. the contraction of the living tissues. This contraction, or astriction, is especially manifested in the skin when exposed to a cooling influence. The cutaneous tissue becomes dry and shrivelled, while the bulbs of the hairs become elevated and manifested; constituting the state called goose-skin (*cutis anserina*). In muscular tissues, spasmodic contraction results from cold. Moreover, this effect extends by sympathy to other muscular parts beyond those to which the cold is applied. The blood-vessels, in common with all other living parts, suffer contraction; and the quantity of blood circulating in them is thereby lessened, while its motion is retarded. The secretions and exhalations are checked or stopped; partly as a consequence of the effect on the circulation of the part, partly by the contraction of the secreting and exhaling vessels. If the cold be excessive, or its action prolonged, the part, after suffering more or less uneasiness, loses its sensibility. This state of torpefaction, or benumbing, when fully established, is denominated *frost-bite;* and, unless speedily relieved, will be soon followed by the death of the part.

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[c] De Candolle, *Physiologie Végétale*, t. 3me, p. 1117. Paris, 1832.

[d] Arnott's *Elements of Physics*, vol. ii. part i. p. 25. Lond. 1829.

"I perceived one day on a journey," says Beaupré[e], "that two officers, prisoners of war, and my companions in misfortune, had the points of their noses of a horn white, the colour of old wax. I warned them, and frictions with snow were sufficient to remove this first stage of congelation, which they had not suspected. But what appeared to them very singular was, that, while I gave them advice, I myself needed the same—my nose was in the same condition; *sibi non cavere et aliis consiliam dare.* From that moment we were on the alert; we kept on our guard; and, that we might not fall victims to a security alike fatal and involuntary, each begged his neighbour, on terms of reciprocal service, to watch over his nose and ears."

"After entire cessation of pain, the part remains cold and insensible; sometimes phlyctenæ arise; sometimes the change of colour in the skin, which is livid and blackish, evinces from the commencement that there is mortification[f]."

Such is a sketch of the primary topical action of continued intense cold. When, however, it is either moderate or only temporarily applied, reaction is readily induced. The disagreeable feeling of cold is succeeded by an agreeable sensation of warmth; the natural temperature returns, relaxation takes place, and the parts acquire their usual volume, colour, and sensibility. When the cold to which the part has been exposed is excessive, and the heat subsequently employed to excite reaction be too suddenly applied, inflammation and gangrene ensue.

Pernio, or *chilblain,* is the effect of inflammation caused by cold.

That gangrene and death readily result from the sudden application of warmth to a frozen part, was known to Hippocrates[g], who states that a man having had his feet frozen, lost them by the application of warm water.

The true method of recovering frost-bitten parts consists in very gradually restoring their natural temperature by the use, first, of snow or ice frictions, then of cold water, and subsequently of luke-warm water.

Hitherto I have considered the effects of cold used topically: I must now notice its effects when employed generally.

Temporary exposure to moderately cold air (from 30° to 45° F.) is agreeable, and, by the re-action which it establishes, exciting to the young and the vigorous. The coldness of surface and diminished capillary circulation, which it at first occasions, are soon followed by re-action, especially if exercise be conjoined. Perspiration is checked and urine promoted. A more intense or a longer continued cold causes shivering, goose-skin, determination of blood to internal organs, coldness of surface, and a kind of spasmodic stiffness. These effects are much more severely experienced by the old, the debilitated, and the paralytic.

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[e] *A Treatise on the Effects and Properties of Cold,* p. 132. Translated by Dr. Clendinning. Edinb. 1826.

[f] Ibid.

[g] *De usu liquidorum,* p. 425, ed. Fæsii.

When the degree of cold is excessive, or its application too prolonged, it causes torpor, irresistible tendency to sleep, apoplexy, asphyxia, and death.

A remarkable and well-known instance of the strong tendency to sleep induced by cold occurred in one of Captain Cook's voyages[h]. Sir Joseph Banks, Dr. Solander, and some others, landed on Terra del Fuego, and were overtaken by night on the hills. Dr. Solander warned the party against giving way to sleep. "Whoever sits down," he observed, "will sleep, and whoever sleeps will wake no more." Yet he was the first who experienced this irresistible desire to sleep, and he insisted upon being suffered to lie down. He was, however, dragged along. Nevertheless, he slept for five minutes, and it was discovered that the muscles of his feet were so contracted that his shoes dropped off.

In both ancient and modern times, military expeditions have furnished dreadful and notorious illustrations of the disastrous effects of cold on the human frame. The Greeks, under the command of Xenophon[i], in their retreat from Persia, and on two occasions under the command of Alexander the Great[j], suffered severely from cold. In more modern times, we have examples of much greater military disasters from cold. In 1719, the Swedes lost, by cold, 5200 out of 7300 men in their retreat from Norway[k]. In 1742, in the retreat of Prague, 4000 Frenchmen perished from cold and misery in ten days[l]. The dreadful sufferings of the French army, in 1812, on its return from Moscow, are too well known to need much notice on the present occasion[m]. Buonaparte invaded Russia with an army of 400,000 men. He left Moscow with only 120,000; and, by the time he arrived at Smolensko, great difficulty was experienced in assembling 40,000 men in fighting order. About 10,000 Frenchmen, and 25,000 auxiliaries, alone remained to return to their native country.

The diseases produced by cold are numerous[n]. Chilblains and frost-bites have been already referred to. Pulmonary affections are by far the most common of the internal maladies induced by cold. Scrofula is a disease of cold and moist climates. Rheumatism is another malady brought on by cold and moisture conjoined. Apoplexy and paralysis, especially in the aged, are occasioned by cold[o]. In addition to the diseases now mentioned, there are many others the progress of which are more or less promoted by cold.

On examining the bodies of persons killed by cold, congestion of the cerebral vessels, and effusion into the ventricles of the brain[p], have always been found.

Therapeutical Uses.—We employ cold for the purpose of obtaining its primary, its secondary, or its total effects[q]. When our object is to procure the first of these effects, we use a more intense degree of cold, and continue it for a longer period than if we are desirous of obtaining the secondary effects only.

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[h] Hawkesworth's *Account of the Voyages for making Discoveries in the Southern Hemisphere*, vol. ii. p. 46. Lond. 1773.

[i] *Cyropædia*, lib. iv.

[j] Pratt's Translation of Quintus Curtius's *History of Alexander the Great*, vol. ii. pp. 157 and 233. Revised ed. 1821.

[k] *Historical Register* for 1719, vol. iv. p. 308-310.

[l] Beaupré, *op. supra cit.* p. 96.

[m] Count Segur's *History of the Expedition to Russia, undertaken by the Emperor Napoleon in* 1812. Lond. 1825.—Beaupré, *op. supra cit.* p. 93.—Sir H. Halford, *Lond. Med. Gaz.* vol. xix. p. 903.

[n] See Dr. Clendinning, in the *Lond. Med. and Phys. Journ.* for June, July, and Sept., 1832.

[o] *Dict. of Pract. Medicine*, art. *Cold.* By J. Copland, M.D.

[p] Kellie, *Trans. of the Medico-chirurgical Society of Edinburgh*, vol. i. p. 84.

[q] Gallot, *Diss. Inaug. De Frigoris Usu Therapeutico.* Berol. 1838.

The following are the principal purposes for which we use cold:—

1. To lessen preternatural heat; as in ardent fever.
2. To reduce excessive vascular action; as in inflammation.
3. To allay exalted sensibility and pain; as in burns.
4. To constringe the living tissues; as when we apply cold to arrest hemorrhage, to relieve congestion, to check profuse exhalation or secretion, to counteract relaxation, and to reduce the volume of enlarged or displaced parts.
5. To make a sudden and powerful impression on the nervous system; as when we use aspersion of cold water to relieve syncope, and immersion in cold water to allay spasm.
6. To strengthen or give tone to a part or the whole of the body; as in the ordinary hygienic uses of the cold plunge-bath and the cold shower-bath.

As cold is thus adapted to produce several objects, so it frequently happens in practice that it is employed to fulfil, simultaneously, several indications.

a. Cool Air.

In febrile diseases, accompanied with preternatural heat, exposure to moderately cool air (from 50° to 60° F.) is both grateful and efficacious. It diminishes the temperature of the body, and reduces excessive vascular action. In the admission of fresh and cool air to patients affected with febrile disorders, consists one of the most important features of the modern improved methods of treating fevers.

b. Cold Water.

1. *Cold, Cool, and Temperate Baths.*—*a. Cold-Bath.* The temperature of this ranges from 33° to about 60° F. When below 50° F., the bath is considered very cold. Its primary effects constitute the *shock*,—its secondary effects, the *reaction* or *glow*.

The sudden abstraction of heat from the surface of the body, and the pressure of the water, produce a powerful effect on the system: a sensation of cold (speedily followed by one of warmth), contraction of the cutaneous vessels, paleness of the skin, diminution of perspiration, and reduction of the volume of the body, are the immediate effects. Shivering, and, as the water rises to the chest, a kind of convulsive sobbing, are also experienced. Continued immersion renders the pulse small, and, ultimately, imperceptible, and the respiration difficult and irregular; a feeling of inactivity succeeds; the joints become rigid and inflexible; pain in the head, drowsiness, and cramps, are experienced; the temperature of the body falls rapidly; and faintness, followed by death, comes on. Many of these symptoms are readily accounted for: the contracted state of the superficial vessels produced by the cold, and the pressure of the water, together cause the blood to accumulate in the internal vessels. The palpitations arise from the efforts made by the heart to rid itself of the increased quantity of blood thrown on it; but the pulse continues small, because the arteries remain contracted. The internal veins becoming gorged, the functions of the brain necessarily suffer:—and hence arise headache, drowsiness, cramps, and, in some cases, apoplexy. The difficult respiration depends on the accumulation of blood in the lungs. The contracted state of the superficial vessels accounts for the diminished perspiration ; while the increased secretion of urine is referrible to the blood being driven towards the internal organs.

In general, the immersion being only temporary, reaction quickly takes place ; a sensation of warmth soon returns ; the cutaneous circulation is speedily re-established ; a glow is felt ; perspiration comes on ; the pulse becomes full and frequent ; and the body feels invigorated. In weakly and debilitated subjects, however, this stage of reaction may not occur, or at least may be imperfectly effected ; and usually, in such cases, the cold bath will be found to act injuriously.

The cold bath is employed with the view of obtaining the nervous impression or shock,—the refrigeration,—or the re-action or glow [r]. It is evident that it ought not to be applied unless there be a sufficient degree of tone and vigour in the system to cause a perfect state of re-action ; and, therefore, in weak subjects, its use should be prohibited. So also, in visceral inflammation, more especially peripneumonia, it is a dangerous remedy ; since the determination of blood to the internal organs is increased by the cold, and it seems even within the range of probability that death might be the immediate result. Apoplectic subjects, who are unaccustomed to cold bathing, had also, for a similar reason, better avoid trying it. In some affections of the nervous system it has been found highly useful ; for example, in tetanus and insanity. In many cases, where it is desirable to increase the tone and vigour of the body, and where the before-mentioned objections do not exist, the cold bath may be used advantageously. It is a common opinion that immersion in cold water is dangerous when the body is heated by exercise, or other exertion ; and hence it is customary with bathers to wait until they become cool. Dr. Currie [s] has strongly combated both the opinion and the practice : the first, he says, is erroneous, the second injurious.

b. The Cool Bath (whose temperature is from 60° to about 75°) is analogous in its operation to the cold bath, but is less powerful. It is commonly used as a luxury, and for cleanliness ; but it may be employed, therapeutically, in the same diseases as the cold bath, where we are in doubt as to the power of the patient's constitution to establish full re-action, after the cold bath. It is frequently resorted to as a preparative to the cold bath.

c. The *Temperate Bath* ranges from 75° to 85° F. Its effects and uses are similar to the cool bath.

2. *AFFUSION* (*Perfusio ;* Κατάχυσις). Affusion was employed, as a hygienic agent and luxury, by the Greeks and Orientalists at a very

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[r] *Cyclopædia of Practical Medicine,* art. *Bathing,* by Dr. J. Forbes.

[s] *Medical Reports on the Effects of Water, cold and warm, as a Remedy in Fever and other Diseases,* vol. i. p. 112.

early period. Homer[t] makes some allusions to it; Hippocrates[u] used it in medicine; and Celsus[v] recommends it in some affections of the head. The last-mentioned writer also states, that Cleophantus (a physician who lived about 300 years before Christ) employed hot affusion in intermittents[w].

The affusion on the head is thus effected:—The water is to be poured on the head (inclined over a pan or tub), by means of an ewer or pitcher, from a height of two or three feet. If the patient be confined to his couch, the head should be inclined over the side of the bed. In children, it is sufficient to squeeze a large sponge (previously soaked in water) at some height above the head, as recommended by Dr. Copland[x]. When the object is to apply affusion to the whole body, the patient is placed in a large tub or pan (*e. g.* a bathing tub or washing pan), and then an attendant, standing on a chair, may readily effect it. The time that the affusion should be continued varies, according to circumstances, from a quarter of a minute to two or three minutes; but in some cases it has been employed for twenty minutes. After the affusion the body should be carefully wiped dry, the patient wrapped up warm, and placed in bed.

The effects of affusion depend partly on the temperature of the liquid, and partly also on the sudden and violent shock given to the system by the mechanical impulse; hence the reason why the effects vary, according to the height from which the water is poured.

a. Cold affusion.—When water whose temperature is between 32° and 60° F. is used, we denominate the affusion *cold.* To a certain extent the effect of cold affusion is analogous to that of the cold bath, but modified by two circumstances, namely, the short period during which the cold is applied, and the mechanical influence of the stream: hence, its primary effects are very transient, and re-action speedily follows. By a long continuance of affusion, however, the heat of the body is considerably reduced, and the same diminution of vital action occurs as when the cold bath is employed. The sensation of cold, the constriction of the skin, and the contraction of the superficial vessels, first experienced in the part to which the water is applied, are very speedily communicated to the rest of the system by sympathy; and the effects are perceived in the nervous, vascular, secreting, and cutaneous systems. The temperature of the whole body falls, the pulse is reduced in fulness and frequency, the respiration becomes irregular, convulsive shiverings take place, faintness; and, in fact, all the previously described effects of the cold-bath are produced. During this condition the excretions are suspended. "When," says Dr. Copland, "the stream of water is considerable, and falls from some height upon the head, the effect on the nervous system is often very remarkable, and approaches more nearly than any other phenomenon with which I am acquainted to electro-motive or galvanic agency."

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[t] *Odyssey*, x. 362.

[u] *Aphorismi*, sect. v. aph. 21; and sect. vii. aph. 42.

[v] Lib. i. cap. 4.

[w] Ibid. lib. iii. cap. 14.

[x] *London Medical Gazette*, vol. x.

After affusion, re-action is soon set up, the heat of the body is re-established, the pulse becomes full and regular, though sometimes reduced in frequency, the thirst is diminished, and frequently perspiration and tendency to sleep are observed.

Cold affusion is used principally in those cases where it is considered desirable to make a powerful and sudden impression on the system: for as a mere cooling agent it is inferior to some other modes of applying water. It is objectionable in visceral inflammation, on account of the determination of blood which it produces to the internal parts. It has been employed with great benefit in *fevers*, both continued and intermittent. It may be used with safety, according to Dr. Currie[y] and others, "when there is no sense of chilliness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration." It is inadmissible during either the cold or the sweating stage of fever, as also in the hot stage, when the heat is not greater than ordinary. In some instances it seems to act by the shock it communicates to the system; for the effect is almost immediate, the disease being at once cut short. The patient has fallen asleep immediately afterwards, profuse perspiration has succeeded, and from that time recovery commenced. This plan of extinguishing a fever, however, frequently fails; and in that event the patient may be in a worse condition: hence the practice is not often adopted. I think the cases best adapted for the use of cold affusion are those in which there is great cerebral disorder,—either violent delirium or a soporose condition. My friend, Dr. Clutterbuck[z], says he has seen pulmonic inflammation and rheumatism brought on by cold affusion in typhus; but he adds, "I have not, in general, observed that the situation of the patient was rendered materially worse by the combination."

In the *exanthemata*, cold affusion has been applied during the fever which precedes the eruption, as also after this has been established; it has been used in scarlet fever, and also in small-pox; likewise in measles; but its employment in the latter disease is objectionable, on account of the tendency to pulmonary inflammation, in which affection cold affusion is prejudicial.

Croup is another disease in which cold affusion has been used with advantage, principally with the view of removing the spasm of the glottis, which endangers the life of the patient.

In *inflammatory affections of the brain*, especially of children, after proper evacuations have been made, it is useful. In many cases of *narcotic poisoning*, cold affusion is of the greatest service; as in poisoning by hydrocyanic acid, and in asphyxia caused by the inhalation of carbonic acid; so also in poisoning by opium, belladonna, and other narcotic substances; in intoxication[a]; in asphyxia from the inhalation of sulphuretted hydrogen gas or of the vapours of burning charcoal, it is most advantageous. In *hysteria* and

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[y] *Op. supra cit.*

[z] *Inquiry into the Seat and Nature of Fever*, 2d ed. p. 451.

[a] *Lond. Med. Gaz.* vol. ix. p. 502*.

epilepsy it is oftentimes serviceable: it diminishes the duration of the paroxysms, and relieves the comatose symptoms. In *puerperal convulsions* Dr. Copland relies on cold affusion and blood-letting. In *mania* it is oftentimes serviceable; as also in *tetanus*. In *malignant cholera* it sometimes proved valuable [b]; principally, however, in mild cases. In severe attacks the power of reaction was insufficient.

b. Cool affusion has been employed instead of the cold; and in weak irritable subjects it is always preferable. Dr. Currie regards it as a milder form of the cold affusion, as a preparatory means to which it is sometimes used. It has been applied in febrile diseases and paralysis.

c. Tepid affusion.—The affusion of tepid water is frequently resorted to as a substitute for that of cold water, where great dread is entertained of the latter agent, or where there is doubt as to the production of a perfect reaction after the application of cold water, or where there is some pulmonary disease. It may be regarded as a safer, though less powerful means. Thus it is very useful in febrile complaints, especially of children. It is very beneficial in scarlet fever, as I have seen on several occasions. Dr. Currie thinks that it reduces the temperature more than cold affusion; first, because the evaporation is greater; secondly, because it does not excite that reaction by which heat is evolved. It diminishes the frequency of the pulse and of respiration, and causes a tendency to sleep. The same writer tells us that he has not found its effects so permanent as those of the cold affusion; and that he never saw it followed by the total cessation of regular fever. In other words, it produces a much less powerful shock to the system, and, therefore, is less influential over disease. In hectic fever, however, the paroxysm is sometimes completely extinguished by the affusion of tepid water at the commencement of the hot stage.

Warm affusion has been already noticed [c].

3. THE SHOWER-BATH (*Impluvium*).—The shower-bath is very similar in its effects to, but milder than, affusion. It is frequently employed as a hygienic agent. In insanity it is used with the greatest benefit to allay mental excitement. In violent cases, "the application of the shower-bath, the patient being up to the middle in warm water, seldom fails to subdue the paroxysms [d]." The period during which it should be continued is a circumstance of some moment. Dr. Conolly observes that it "should be suspended when the patient appears overcome, and instantly renewed when symptoms of violence recur. A strong shower continued even for a minute, has sometimes considerable effect;" and it should never be "many minutes prolonged without careful observation of the patient's state. After four or five applications of this kind, the patient becomes entirely subdued, and should then be taken out of the bath, rapidly dried, warmly covered up, and put into bed; with every possible demonstration of kind attention.

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[b] *Lond. Med. Gaz.* vol. ix. pp. 452, 502, and 5(5.

[c] See p. 20.

[d] Dr. Conolly's *Report* before quoted, p. 66.

Calmness and sleep are the usual results: and more permanent effects frequently follow. A bath of this kind appears to produce a moral as well as a physical impression; being succeeded, in recent cases, by tranquillity for a few days, and in chronic cases by quietness and improved behaviour for many weeks, and sometimes even for months."

The shower-bath is sometimes a valuable substitute for the cold bath or cold affusion, than which it is less likely to occasion cramp or other disorder of the nervous system. Tepid or even warm water may be used where we wish to reduce the violence of the shock.

An extemporaneous shower-bath may be produced by the aid of a cullender. It may be used to allay the violent delirium of fever; and is rendered more beneficial if the patient can be persuaded to sit in a semicupium of warm water[e].

4. *The Douche* (*Duccia*). The term *douche* is applied to a column or current of fluid directed to, or made to fall on, some part of the body. It is uncertain at what time it came into use. Cælius Aurelianus[f] has been supposed by some to refer to it in the following passage:—" Item *aquarum ruinis* partes in passione constitutæ sunt subjiciendæ, quas *Græci* κατακλυσμοὺς appellant, plurimum etenim earum percussiones corporum, faciunt mutationem."

The fluid employed is either water or aqueous vapour: hence we have the *liquid douche* and the *vapour douche*. According to the direction in which the fluid is applied, we have *the descending*, *the lateral*, and *the ascending douche*.

The effect of the liquid douche depends in part on mechanical action or percussion, which, by continuance, excites topical pain and inflammation; and in part on the temperature of the liquid. The local excitement more speedily occurs from hot than cold water; indeed the long continued action of a stream of cold water may act as a sedative, and cause the primary effects of cold before described. The effect of the douche is not wholly local, since the neighbouring parts, and even the whole animal economy, soon become affected. A column of water twelve feet high, made to fall perpendicularly on the top of the head, excites such a painful sensation, that, it is said, the most furious maniacs, who have once tried it, may sometimes be awed merely by the threat of its application; and hence one of its uses in madness, as a means of controlling the unfortunate patient. " At this moment a controversy is proceeding among certain French physicians concerning the application of the douche; which some are disposed to use as a specific against delusive notions. The patient is kept under the douche until he entirely recants. The principle is extremely doubtful; and it should be remembered of every severe application, that lunatics are seldom able to make their real sufferings distinctly known. M. Esquirol subjected himself to the douche; and he describes the sensation as very painful; resembling the continued breaking of a column of ice on the head, followed by a feeling of stupefaction, which lasted an hour afterward[g]." Probably all the good effects of the douche may be obtained by the shower-bath, the application of which is much less distressing to the patient.

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[e] Dr. Lendrick, *Lond. Med. Gaz.* vol. ii. N. S. p. 104.

[f] *Morbor. Chronicor.* lib. ii. cap. 1.

The cold douche is applicable to some cases of local diseases requiring a powerful stimulus; as old chronic affections of the joints, whether rheumatic, gouty, or otherwise[h]; paralytic affections; sciatica; old glandular swellings: chronic headache; deafness, &c. Dr. Butzke[i] has recently employed it with good effect in old ulcers of the feet. In some of the preceding cases a warm, is used instead of the cold, douche.

The operation of *pumping* practised at Bath, may be regarded as a kind of douche, and is used in the same cases. The degree or extent of the application is determined by the number of times the handle of the pump is raised or depressed. From 20 to 200 strokes of the pump is the number generally directed to be taken at one time, which, however, may be increased or diminished according to the age, sex, strength, or other circumstances of the patient[j]. The water does not issue in gushes, but in a continuous stream.

5. *Lavation, Washing, or Sponging.*—Cold, cool, or tepid washing or sponging, may be used in febrile diseases, with great advantage, in many cases where affusion is not admissible, or where timidity on the part of the patient or practitioner prevents the employment of the latter. Dr. Currie[k] remarks, that in all cases of fever where the burning heat of the palms of the hands and soles of the feet is present, this method of cooling them should be resorted to. A little vinegar is frequently mixed with the water, to make the effect more refreshing. Washing or sponging must be effected under precisely the same regulations as those already laid down for affusion.

6. *Cold Lotions.*—Aqueous and spirituous liquors are employed as lotions to generate cold by evaporation, and thereby to relieve local irritation and inflammation. They should be applied by means of a single layer of thin muslin or linen, and not by a compress. The cold is considerably increased by blowing on the part. Evaporating lotions are applied to the head with great relief in cephalalgia, phrenitis, fever with disorder of the cerebral faculties, and poisoning by opium. In ophthalmia, fractures of the bones of the extremities, severe bruises, and erysipelatous inflammation, cold lotions are used with benefit. Dr. Kinglake[l] recommended the application of cold water to parts affected with gout, but the practice is somewhat hazardous. One method of treating burns is by the application of cold water to the injured part. In modern times, Sir James Earle[m] was the great advocate

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[g] Dr. Conolly's *Report* before cited, p. 68.

[h] See some observations of Lisfranc on the use of the Douche in White Swelling, in the *Lancet*, vol. ii. 1834—5, p 337.

[i] *London Medical Gazette*, N. S. for 1839-40, vol. i. p. 893.

[j] *A Practical Dissertation on the Medicinal Effects of the Bath Waters*, by William Falconer, M.D. 1790.

[k] *Reports*, vol. i. p. 72, 4th ed.

[l] *A Dissertation on the Gout.* Lond. 1804.—*Additional Cases of Gout.* Lond. 1807.

[m] *An Essay on the Means of lessening the Effects of Fire on the Human Body.* Lond. 1799.

for this plan, which proves more successful in scalds and slight burns. The burnt part should be covered with rags, and kept constantly wetted with water, in which ice is placed from time to time; "care being taken never to remove the rags from the burnt surface[n]."

If the cold fluid be continually renewed, the practice has been called *irrigation*[o]. It is effected either by allowing cold water to drop on the affected part, from a stopcock inserted in the side of a bucket of water, or by conducting a stream of water from a vessel by means of a strip of cloth, on the principle of a syphon.

7. *Cold Drinks.*—Hippocrates[p], Celsus[q], and other ancient writers, employed cold water as a drink in ardent fever. In modern times also it has been extensively used in the same malady. Dr. Hancocke[r] called it the *febrifugum magnum.* Its employment, however, has not been limited to fever. From its supposed great efficacy in gouty complaints, Heyden[s] termed it the *arthritifugum magnum.* Within the last ten years, thirteen or fourteen establishments have been set up in Germany, for the cure of diseases by cold water. This mode of treatment is denominated *Wasserheilkunst*, or *Wasserkur* (Water-cure)[t].

We are indebted to Dr. Currie for the examination of the circumstances under which the employment of cold water in fever is proper. According to him, it is inadmissible during the cold or sweating stage, but may be employed with safety and advantage when the skin is dry and burning: in other words, the regulations for its administration are precisely the same as for cold affusion. When exhibited under proper circumstances, it operates as a real refrigerant, reducing preternatural heat, lowering the pulse, and disposing to sweating. Occasionally, however, serious and even fatal consequences have resulted from the employment of large quantities of cold water by persons who have been rendered warm by exercise and fatigue.

Besides fever, there are several other affections in which cold water is an useful remedy. For example, to facilitate recovery from epilepsy, hysteria, and fainting; and to alleviate gastric pain and spasm. Large draughts of cold water have sometimes caused the expulsion of intestinal worms, (*Tænia* and *Ascaris vermicularis*).

8. *Cold Injections.*—*a.* Cold water is thrown into *the rectum* to check hemorrhage, to expel worms, to allay local pain, to rouse the patient in poisoning by opium, to stop hemorrhage, and to diminish vascular action in enteritis.

b. Dr. A. T. Thomson[u] speaks very favourably of the effects of cold water introduced into the *vagina*, by means of the stomach-pump, in uterine hemorrhage.

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[n] *Two Lectures on the Primary and Secondary Treatment of Burns,* by H. Earle. Lond. 1832.

[o] Macartney, *Treatise on Inflammation,* p. 158. Lond. 1838.

[p] *De usu liquidorum.*

[q] Lib. iii. cap. 7.

[r] *Febrifugum Magnum; or Common Water the best Cure for Fevers, and probably for the Plague.* 5th ed. Lond. 1723.

[s] *Arthritifugum Magnum: A Physical Discourse on the Wonderful Virtues of Cold Water.* Lond. 1724.

[t] I must refer the reader to the article *Aqua*, for a short notice of this mode of treatment.

[u] *Elements of Materia Medica and Therapeutics,* vol. ii. p. 78. Lond. 1833.

3. *Ice and Snow.*

The temperature of these agents does not exceed 32° F. They are employed both internally and externally.

1. *Employed externally.*—The topical effects (primary and secondary) of cold agents have been already described[k]. Ice, snow, and ice-cold water, are employed externally to obtain sometimes the primary, at other times the secondary, effects of cold.

a. For the Primary Effects.—Ice is used to check hemorrhage, more especially when the bleeding vessel cannot be easily got at and tied. Thus, after operations about the rectum (more especially for piles and fistula), bleeding sometimes occurs to a most alarming extent; and, in such cases, our principal reliance must be on cold. In two instances that have fallen under my own observation, I believe the lives of the patients were preserved by the introduction of ice within the rectum. In many other cases of hemorrhage, the external application of cold (either in the form of ice or ice-cold water) is exceedingly useful. Thus, applied to the chest in dangerous hemoptysis, and to the abdomen in violent floodings, it is oftentimes very beneficial. In some of these cases, especially in uterine hemorrhage, more benefit is obtained by pouring cold water from a height (*cold affusion* or *douche*), than by the mere use of ice.

A bladder, containing pounded ice, has been applied to hernial tumors, to diminish their size and facilitate their reduction; but notwithstanding that the practice has the sanction and recommendation of Sir Astley Cooper[l], it is, I believe, rarely followed, not having been found successful; while, if too long continued, it may cause gangrene. In this, as well as in other cases, where ice or snow cannot be procured, a freezing mixture may be substituted. For this purpose, five ounces of muriate of ammonia, five ounces of nitre, and a pint of water, are to be placed in a bladder, and applied to the part. Ice has also been applied in prolapsus of the rectum or vagina, when inflammation has come on, which threatens to terminate in mortification.

In inflammation of the brain, the *ice-cap* (*i. e.* a bladder containing pounded ice) is applied to the head with great benefit. In fever, also, where there is great cerebral excitement, with a hot dry skin, I have seen it advantageously employed. In apoplexy, likewise, it might be useful; as also in mania, with great mental excitement. In the retention of urine, to which old persons are liable, ice-cold water applied to the hypogastrium is sometimes very effective, causing the evacuation of this secretion.

b. For the Secondary Effects.—Friction with ice or snow is employed to produce the secondary effects of cold in diminished sensibility of the skin, and in the rheumatism or gout of old and enfeebled persons; but its most common use is as an application to frost-bitten parts. The feet, hands, tip of the nose, and pinna of the ear, are the organs most frequently attacked. In order to guard against mortification, and other ill effects arising from a too rapid change of temperature, the vital properties must be slowly and gradually recalled. In order to effect this, the frostbitten part should be rubbed with snow or pounded ice, or bathed in ice-cold water, very gradually raising the temperature of the applications until the part acquires its natural heat.

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[k] See page 22.

[l] *The Anatomy and Surgical Treatment of Inguinal and Congenital Hernia,* p. 25. Lond. 1804.

2. *Employed internally.*—When ice or ice-cold water is swallowed, the sensation of cold which it produces is neither so acute as that occasioned by the application of ice to the skin, nor so prolonged. For the sensibility of the alimentary tube is less than that of the external integument, while its temperature is higher; so that the ice is sooner melted, and the liquid quickly raised to the temperature of the body. But when swallowed in considerable quantity, the effects of ice are of the same kind as those already described for cold generally. A sensation of cold at the epigastrium is experienced, and sometimes shivering occurs. The pulse is diminished in frequency. Temporary contraction of the alimentary canal, and diminution of irritability and secretion, are produced. When ice is taken in small quantity only, these primary effects are very slight or scarcely noticed, and the stage of re-action quickly succeeds. A feeling of warmth follows that of cold at the epigastrium, and quickly extends over the whole body; the circulation is somewhat accelerated; and the secretions of the alimentary canal, of the kidneys, and of the skin, are promoted. If the re-action be excessive, gastric inflammation may be induced.

Ice, or ice-cold water, is swallowed for the purpose of obtaining either the primary or secondary effects of cold. Thus it is taken to cause contraction of the gastric vessels, and thereby to check or stop sanguineous exhalation from the mucous membrane of the stomach. It has also been found beneficial in nasal, bronchial, and uterine hemorrhage. In the latter cases, the constriction of the bleeding vessels must be effected through sympathetic relations which exist between the stomach and other organs. Ice is also employed to relieve cardialgia, vomiting, and spasmodic pain of the stomach. In the latter stage of typhus fever, the internal use of ice is sometimes beneficial.

3. ELECTRICITAS.—ELECTRICITY.

Physiologists[m] have long suspected that electricity was the cause of some vital phenomena; and various circumstances lend support to this notion. Among these may be mentioned the extensive agency of this force in the production of the physical and chemical phenomena of the external world;—its well-known remarkable influence on the animal economy;—and, lastly, its development by some fishes, as the *Torpedo vulgaris* and *Gymnotus electricus*. Hitherto, however, no one has succeeded in establishing the identity of electricity and the cause of vital phenomena.

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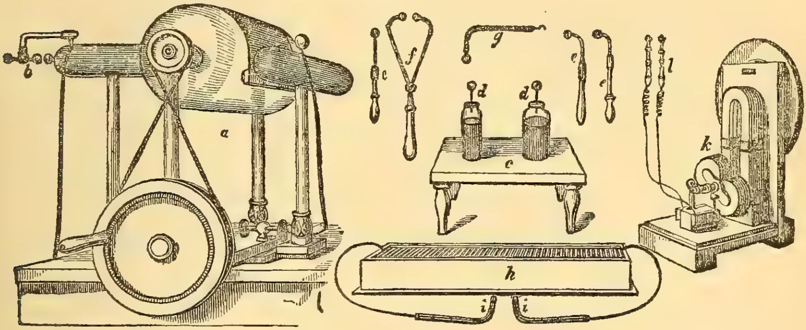
[m] Mr. Abernethy (*Enquiry into the Probability and Rationality of Mr. Hunter's Theory of Life*, Lond. 1814), adopting the notion of several preceding physiologists, that life depended on an internal principle distinct from the body,—suggested that this principle was electricity; or if not electricity, "at least we have reason to believe," he says, that "it is of a similar nature, and has the power of regulating electrical operations."—In 1809, Dr. Wollaston (*Phil. Mag.* vol. xxxiii. p. 488) suggested that the products of secretion might be due to electricity of low tension; and the accuracy of this opinion Dr. Wilson Philip (*An Experimental Enquiry into the Laws of the Vital Functions*) has endeavoured to prove experimentally. Meissner has carried the hypothesis of electricity being the cause of vital phenomena to a most extravagant length (see Müller's *Elem. of Phys.* trans. by Baly, vol. i. p. 73). That the active principle of the nerves is electricity has long been a favourite opinion. Though many objections have been raised to it (see Müller, *op. supra cit.* pp. 72 & 633), yet it has recently received additional support from Prof. Zantedeschi and Favio (*Lond. Ed. & Dubl. Phil. Mag.*

Electricity may be obtained from various sources; but the quantity and condition of this agent, as procured by different methods, are by no means uniform. *The common electric machine* yields, by the friction of its glass cylinder or plate on the rubber, a small quantity of electricity whose tension or elasticity is great, and which, therefore, is capable of exerting attractive and repulsive forces not merely at sensible, but at considerable, distances. We denominate this, *friction*, *ordinary*, *common*, or *Franklinic electricity*. The electricity procured from *the atmosphere*, by *the cleavage of crystals*, and by *pressure*, is of the same kind. By chemical action, however, we put in motion an immense quantity of electricity, whose tension is very low, and we distinguish it by the name of *Voltaic electricity* or *Galvanism*. The electricity obtained by a *magneto-electric machine* is of the latter kind.

FIG. 2.



Electrical Apparatus for Medical Purposes.

FRICTION ELECTRICITY.

a. Cylinder Machine.
b. Medical Electrometer.
c. Insulating Stool.
d d. Leyden Jars.
e e e. Insulated Directors.
f. Discharging Rod.
g. Glass Tube traversed by a wire, which terminates at one end by a loop, at the other by a brass ball.

VOLTAIC ELECTRICITY.

h. Cruickshank's Wooden Trough.
i i. Directors, each consisting of a glass tube traversed by a wire, an extremity of which is connected with one end of the trough,—while the other extremity is surmounted by sponge or flannel moistened with salt and water.

MAGNETIC ELECTRICITY.

k. Clarke's Magneto-electric Machine.
l. Directors.

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for April, 1841), who assert, that independent of *common electro-chemical* and *thermo-electric currents*, there exist in animals two *electro-vital* or *neuro-electric currents*—one external or cutaneous, moving from the extremities to the cerebro-spinal axis; the other internal, going from the cerebro-spinal axis to the internal organs situated beneath the skin. Pain, it is said, weakens or suspends the current, while the voluntary or convulsive automatic movements give a very strong current, which may be named discharge of current.

a. *Friction Electricity.*

(Common or Franklinic Electricity.)

The apparatus, requisite for the medical application of friction electricity, consists of the following instruments:—

1. A cylindrical or a plate machine. If a cylinder, the diameter should be at least from 8 to 14 inches; if a plate, from 18 to 24 inches. The amalgam used for the rubber is composed of one part tin, two parts zinc, and six parts mercury.
2. A medical electrometer, to regulate the force of the spark or shock.
3. One or two Leyden jars.
4. An insulating stool or chair.
5. A discharging rod.
6. Two or three insulated directors. The brass ball which surmounts each director may be occasionally unscrewed and removed, and a point brought into view.
7. Flexible metallic wire or chain. A brass chain is generally employed; but the spiral brass wire employed for braces is more convenient: it may be enclosed by a silk ribbon.

Physiological Effects. *a. On Vegetables.*—It is a popular opinion, perhaps founded in fact, that atmospheric electricity promotes vegetation; but the arguments adduced to prove it are somewhat vague. It is said that those years in which the greatest number of thunder-storms occur are the most productive; and that hops, barley, wheat, vines, &c. shoot up much more rapidly after a storm. These statements may, however, be true, without the inference which has been drawn from them being correct. Mushrooms form, it has been said, an exception to this statement; their growth being retarded by electricity[n]. Some electricians have affirmed that artificial electricity promotes the germination of seeds as well as the growth and green colour of plants; but the accuracy of the statement is exceedingly doubtful. De Candolle says he has observed transpiration increased by it. The movements of the sensitive plant and of the stamina of the barberry may be excited by electricity.

b. On man and other animals.—The effects of electricity on animals vary according to the mode of applying it; and hence they may be conveniently described under five heads:—

1. *The Electric Bath.*—In this mode of employing electricity the patient is placed on the insulating stool (or chair), and in connexion with the prime conductor of the machine. The whole surface of the body becomes electro-positive, while the air which surrounds the body is, by induction, rendered electro-negative. The positive electricity is constantly and silently discharged from all pointed parts of the surface, as from the hairs, fingers, &c. In a darkened room the discharge is seen to be attended with the evolution of light. The effect of the electric bath does not appear to be uniform on different individuals. In some the pulse is at first quickened, in others it is unchanged; while in some it is, after ten or fifteen minutes, reduced in frequency[o]. These different effects are, undoubtedly, in part

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[n] De Candoîle, *Physiol. Vég.* t. iii. p. 1091.

[o] See Mr. Smith's experiments, in Dr. Hodgkin's Translation of Edwards' work, *On the Influence of Physical Agents on Life*, p. 335. Lond. 1832.

referrible to the influence of mental emotion. Copious perspiration sometimes breaks out while the patient is on the insulating stool.

2. *Electric Aura.*—This is produced by the action of a current of electrified air on the skin. It is applied by means of an insulated pointed director, connected with the prime conductor by a wire or chain; its point being turned to the part intended to be electrified. In this way a current or breeze of highly excited air is directed towards the part. Or the aura may be drawn from the patient while placed on the insulating stool, by means of an uninsulated metallic point. The electric aura operates as a mild stimulant, and is occasionally used when we are desirous of electrifying delicate parts—as the eye, ulcers, excoriated surfaces, the testicles, &c.

3. *The Electric Spark.*—This is one form of the disruptive discharge. It may be communicated by presenting to the part to be electrified, the ball or knob of an insulated director connected with the prime conductor. Or it may be drawn from the patient by placing him on the insulating stool (or chair), and bringing the knuckle or the ball of an uninsulated director near him. The opposed surfaces, between which the spark passes, are in oppositely electrified conditions. The nearer they are together, and the smaller the ball, the weaker is the force of the spark. A succession of very small sparks is obtained by substituting a wooden point for the metallic ball.

The spark occasions a sharp, painful, pungent sensation, redness, and sometimes a small circumscribed spot or wheal, which, however, in general quickly disappears.

For internal parts, as the bottom of the meatus auditorius externus, a glass tube is used to insulate the conducting wire, the end of which terminates in a very small knob, contained within, or placed at the end of, the tube (fig. 2, *g*.)

A favourite mode of employing electric sparks is *to draw them through flannel*, as recommended by Cavallo[p], and since practised with great success by my friend, Mr. Charles Woodward. This method is called by some electricians *electric friction.* The patient being placed on the insulating stool, takes hold of the chain communicating with the prime conductor, by the hand opposite to the side to be electrified. Over the naked part is then placed a piece of flannel, and, the machine being turned, the operator places the knob of an uninsulated director in close contact with the flannel, and moves it steadily but rapidly so as to draw a vast number of very small sparks. Mr. Woodward says it is essential, for the success of the practice, that the motion of the ball should be down the part affected; that is, in the direction of the ramifications of the nerves. The operation is to be continued for twenty or thirty minutes. It excites an agreeable warmth, but no very disagreeable sensations. When an uneven surface (as of the face and hands) is to be electrified, the ball of the director should be covered with flannel.

4. *The Electric Shock.*—This is a violent effect of the disruptive

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[p] *Complete Treatise on Electricity*, vol. ii. p. 136. 3d ed. Lond. 1786.

discharge, and is thus effected. Charge a Leyden jar: then connect its outside by a chain or wire with the ball of an insulated director, which is applied to one extremity of the part through which the electricity is intended to pass. The knob of the jar is then applied to the other extremity of the part, and the discharge instantaneously takes place.

The force or the strength of the charge is graduated by interposing in the circuit a medical electrometer (see fig. 2, *b*), which is employed thus:—Place the Leyden jar so that its interior may be in communication with the prime conductor, while its exterior is connected with the patient by a chain and insulated director. One of the knobs of the electrometer is then put in communication with the opposite side of the patient by a second chain and director. If the machine be now turned, the jar charges, and, when the tension is sufficiently high, a spark passes from the prime conductor to the ball of the electrometer, and the discharge takes place, the patient experiencing the shock. To increase or diminish the force or strength of the shock, we augment or lessen the space between the prime conductor and the ball of the electrometer.

Sometimes a coated glass tube is substituted for the Leyden phial in the above arrangement, the medical electrometer being employed. The patient then receives a rapid succession of slight shocks, constituting what some electricians denominate *electrical vibration*.

When a portion of the body makes part of the circuit through which the discharge of a Leyden phial is effected, a sudden, instantaneous, and painful sensation is produced, which is denominated *the shock*. If the charge be passed through the arms, the effects are principally experienced in the wrists, elbows, and across the breast. "If the charge is passed through the spine, it produces a degree of incapacity in the lower extremities; so that if a person be standing at the time, he sometimes drops on his knees, or falls prostrate on the floor[q]." If the diaphragm form part of the circuit, it is immediately thrown into a temporary state of contraction. Mr. Singer "once accidentally received a considerable charge from a battery through the head; the sensation was that of a violent but universal blow, followed by a transient loss of memory and indistinctness of vision, but no permanent injury ensued." If a strong charge of a battery be passed through the head of a rabbit, temporary blindness or death ensues. In persons killed by lightning, red streaks are frequently observed on the skin. It is said that marks are often observed indicating the passage of the electric fluid along the spine. The blood is usually fluid, and the muscles flaccid; though occasionally rigidity of muscles has been found.

The greater or less violence of the shock depends not on the quantity merely, but on the intensity of the charge. Thus a small jar highly charged will produce a greater effect than a large battery feebly charged. But of course if the intensities be equal, the greatest shock is perceived when the largest quantity is employed.

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[q] Singer, *Elements of Electricity*, p. 296. Lond. 1814.

5. *The Electric Current.*—To cause a current to pass through a patient to the ground, connect some part of the body directly, or indirectly by a chain or wire, with the prime conductor of the machine; the patient standing on the ground. By this means the current passes into the body at the point of connexion, and escapes by the feet. Its effects are exceedingly slight, and scarcely, if at all, obvious.

USES.—The uses of electricity are partly rational, partly empirical. When the indications are to excite a nerve of sensation or of motion, or to produce a temporary contraction of muscles, or to promote transpiration and secretion, its employment may be regarded as rational. But it is used, sometimes beneficially, in several diseases in which these indications are by no means obvious. In such, its *methodus medendi* is unknown, and its use may be regarded as empirical.

1. *To stimulate the nerves of sensation.*—In nervous *deafness* electricity is sometimes employed. Sparks are thrown on, or drawn from, the mastoid process, the parts around the meatus auditorius externus, or the bottom of the meatus. In some cases slight temporary relief is obtained. In *amaurosis,* the current, the aura, and sometimes slight sparks and shocks have been tried, but rarely with success[r]. In *topical numbness* unconnected with lesion of the nervous centres, electric friction, sparks, or very slight shocks, are occasionally serviceable.

2. *To excite the motor nerves.*—In partial *paralysis*, benefit is at times obtained by the use of electric friction and slight shocks. When the disease depends on some lesion of the cerebro-spinal centre, relief by electricity is not to be expected. Electricity is calculated to be serviceable when the malady arises from some functional disorder of the nerves. It may also contribute to restore the use of parts originally paralysed by effusion in some part of the cerebro-spinal centre, but which has been gradually absorbed, leaving the limb paralysed from desuetude. These cases, however, are comparatively rare. Notwithstanding the favourable account of its efficacy given by Dr. Golding Bird[s], my own experience of its use leads me to give an unfavourable report of it in cases of paralysis properly so called. *In chronic rheumatism* I have occasionally seen benefit from the use of electricity. *In stiffness and rigidity*, after sprains and bruises, when all inflammation and tenderness have subsided, it has also been employed.

3. *To promote secretion.*—In *amenorrhœa*, considerable benefit is obtained by passing shocks through the pelvis (from the sacrum to the pubis). I have, on several occasions, found the practice successful. Electric friction, or slight shocks, are sometimes employed *to promote the biliary secretion.* My friend, Mr. Woodward, is very sanguine as to its efficacy for this purpose; but I have had no experience of it.

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[r] Mr. Hey published several successful cases of its use in amaurosis. He never saw the least benefit from its employment when the disease had existed for two years (*Med. Observ. and Inq.* vol. v. p. 1. Lond. 1779. 2d ed.)

[s] *Guy's Hospital Reports*, vol. vi. p. 98.

4. *To promote absorption.—In indolent tumours*, electricity, in the form of sparks, slight shocks, and friction, has been employed, and, it is said, with occasional benefit. In enlarged cervical glands I have tried it in several cases, but without observing that any benefit resulted therefrom.

5. *In chorea* and some other allied convulsive disorders, considerable benefit is occasionally obtained from the employment of electricity, in the form of friction or slight shocks in the course of the spine and limbs. I am acquainted with several remarkably successful cases of its use. Dr. Addison[t] and Dr. Golding Bird[u] have also found it beneficial. Its *methodus medendi* is quite inexplicable.

β. Voltaic Electricity.

(Galvanism; Voltaism.)

The apparatus usually employed for the medical application of voltaic electricity consists of—

1. Two wooden troughs (devised by Mr. Cruickshanks), each containing 50 pairs of copper and zinc plates, 2 or $2\frac{1}{2}$ inches square. These may be charged with a solution of common salt, or with a weak acid liquor. Some electricians employ 1 part of common muriatic acid, and 16 or 20 parts of water. Singer thinks that $\frac{1}{500}$ of muriatic acid will be found the most useful. In some cases where the skin was very susceptible I have used water only.
2. A pair of insulated directors, each consisting of a glass tube traversed by a copper wire. One extremity of the wire is in communication with one end of the trough; the other extremity is covered with sponge or flannel, moistened with a solution of common salt.
3. Copper wire to connect the directors with the ends of the troughs.

Harrington's electrizers are plates of copper and zinc, or silver and zinc, made in various forms. Thus for the toothache a plate of copper is soldered edgeways to one of zinc, and worn in the mouth: the saliva serves to excite the apparatus. In another contrivance an hexagonal plate of zinc is connected by its face to a plate of silver: and a series of these compound plates are connected together by wire, so as to move on each other like hinges. These are worn next the skin for the relief of rheumatism. The perspiration serves to excite the plates. Silver and zinc spangles also have been employed, instead of the plates just mentioned.

Physiological Effects.—The physiological effects of voltaic electricity are threefold; viz.—

1. The production of certain sensations.
2. The contraction of muscular fibre.
3. An influence over secreting organs.

1. *Production of certain sensations.*—Although electricity acts on all the organs of sense, yet the nerve of each sense is affected in a manner peculiar to itself. Thus, by acting on *the nerves of touch*, we produce pain, the shock, and other disagreeable sensations: by affecting *the optic nerve*, we occasion a sensation of light: by influencing *the gustatory nerve*, a remarkable taste is excited: by affecting *the auditory nerve*, a peculiar sound is excited[v]. *The olfactory nerve* is influenced by electricity with more difficulty. Volta could not succeed in producing an effect on the sense of smell;

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[t] *Guy's Hospital Reports*, vol. ii. p. 493.

[u] Ibid. vol. vi. p. 84.

[v] Volta, *Phil. Trans.* for 1800, p. 403.

which he ascribes to the circumstance of the electric effluvia not being expanded in and conveyed by the air, which, it is thought, is the proper vehicle for exciting sensations in the olfactory nerves. Cavallo[w] and Ritter[x] each assert, however, that they have produced peculiar smells by electricity[y].

The sensations excited by the passage of the voltaic current through the sensitive nerves may be owing to the mechanical or chemical influence of the current; and not any thing peculiar to the electricity. Thus the nerves of touch, the optic nerve, and the auditory nerves, have each their special sensations excited by mechanical violence. The acid, or the alkaline taste produced by electricity, may be referred to the electrolysis of the salts of the saliva, and the development of an acid and an alkali at the opposite electrodes; and the metallic taste may be owing to the chemical action of the constituents of the saliva on the electrode, by which a soluble metallic compound is produced.

2. *Contraction of muscular fibre.*—Voltaic electricity excites muscular contractions when applied to the motor nerves, or to the central organs of the nervous system. The effect is produced not only on living, but on recently killed, animals; and is more powerful on the voluntary, than on the involuntary, muscles.

MM. Prevost and Dumas[z] have proposed an electrical theory of muscular contraction, which appears to me to be disproved by anatomical and physiological, as well as by physical, considerations. They assert that the nervous fibres run transversely across the muscular fasciculi; that when the muscular fibres become shorter by contraction, they do so by assuming a zig-zag inflexion; that the nervous fibres are conductors of a voltaic current; and, lastly, that zig-zag inflexion is produced by the mutual attraction of the parallel rectilineal currents in the nerves, the muscular fibre itself being passive. But not one of these assumptions can be admitted. Schwann[a] has shewn that Prevost and Dumas mistook entire nervous fasciculi for primitive nervous fibres. Prof. Owen and Dr. A. Thompson[b] doubt whether the zig-zag inflexion exists during contraction. Prof. Owen says that the fibres become shorter and thicker, and only assume a wavy or zig-zag arrangement after contraction has ceased. Lastly, we have yet to learn how the voltaic current is insulated in the nerves, and prevented passing off laterally; for the neurilemma, and the other soft tissues, are excellent conductors of electricity[c].

3. *Influence over the secreting organs.*—Of the great influence exercised by the nerves in the process of secretion, no doubt can be entertained. Now, it appears highly probable, that as the voltaic current excites the functions of the sensitive and motor nerves, it also may exercise a similar influence over those nerves which are distributed to the organs of secretion. Dr. Wilson Philip[d] has endeavoured to establish the truth of this opinion in the case of the

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[w] Wilkinson's *Elements of Galvanism*, vol. i. p. 223. Lond. 1804.

[x] Müller's *Elements of Physiology*, translated by Baly, vol. i. p. 623. Lond. 1838.

[y] The peculiar smell evolved by working the ordinary electric machine in the atmosphere,—by electric sparks, and in some electro-chemical decompositions, is ascribed by Schönbein to a new elementary substance, which he terms *ozone* (from ὄζω, *I smell*), and which is evolved at the anode or positive surface. He supposes it to be a constituent of an electrolyte, small quantities of which exist in both air and water. (*Athenæum* for 1840, p. 742).

[z] Edwards, *De l'Influence des Agens Physiques*, p. 531. Paris, 1824.

[a] Müller, *op. supra cit.* p. 900.

[b] Ibid. p. 887.

[c] Ibid. p. 635.

[d] *An Experimental Inquiry into the Laws of the Vital Functions*, pp. 111, 213, 256, &c. 3rd edit. Lond. 1826.

secretion of the gastric juice. He divided the nervi vagi in a rabbit, and found, as he supposed, that the digestive process was stopped. In another experiment he restored, as he tells us, the functions of these nerves by the voltaic influence. But subsequent experiments have shown that the division of the nervi vagi does not wholly stop the digestive process, and that electricity cannot restore it to its original state[e].

USES.—The therapeutic uses of voltaic electricity, like those of common electricity, are partly rational, partly empirical.

1. *To stimulate the sensitive nerves.*—In cases of nervous *deafness*, voltaic electricity has been used to stimulate the auditory nerve. For this purpose, one wire (pole or electrode) is introduced into one ear, and the other wire (pole or electrode) into the opposite ear. The circuit is then to be rapidly broken and completed a number of times. In *amaurosis*, the same remedy has been used empirically, to stimulate the retina, when other remedies have failed. It must, however, be employed with great caution, as its mechanical effect is calculated in many cases to aggravate the malady.

2. *To excite the motor nerves.*—In *paralysis*, voltaic electricity is occasionally resorted to, but, for the most part, empirically. It can, of course, be of no avail if the disease arise from organic changes in the nervous centres. But when the malady appears to be functional only, or when there is reason to suppose that the blood effused in the brain has been absorbed, and that the paralysis remains from desuetude only, stimulating the motor nerves by electricity may perhaps prove serviceable. In *asphyxia* from drowning, hanging, the inhalation of noxious gases, &c. voltaic electricity is occasionally employed to excite the muscles of respiration. It appears to be a very plausible remedy, but in the cases in which it has hitherto been tried on the human subject, it has mostly failed to effect resuscitation[f]. In *sanguineous apoplexy*, Dr. W. Philip suggests that it might be used to enable the lungs "to perform their functions for a longer time than without this aid," and that by it the life of the patient may be prolonged. In the asphyxia produced by *concussion*, galvanism has been suggested by M. Goudret.

3. *In Asthma and Dyspepsia.*—Dr. Wilson Philip, having observed that withdrawing a considerable part of the nervous influence from the stomach and lungs deranges the digestive powers, and produces great difficulty of breathing, was led to expect relief from galvanism in indigestion and habitual asthma. He describes the benefit obtained as greatly exceeding his expectations. The positive pole (*anelectrode*) is applied to the nape of the neck,—the negative pole (*cathelectrode*) to the pit of the stomach. A weak power should be commenced with, and the strength gradually increased until some

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[e] Müller, *op. ante cit.* p. 549.

[f] The Professors of the Irish College of Surgeons, in 1829, failed to restore by it the respiratory movements in a person who had been hung (Dr. Apjohn, in *Cyclopædia of Practical Medicine*, art. *Galvanism*).—Electricity, in conjunction with other means, was tried, but without success, in the case of Scott, the American diver, who had been accidentally hung for five or six minutes (see *Times*, Jan. 13, 1841).

uneasiness is experienced. In some instances perfect cures were obtained; in others relief was gained[g].

4. *To electrolyze urinary calculi.*—Prévost and Dumas[h] have proposed voltaic electricity as a means of destroying some kinds of urinary calculi. They state that a fusible calculus, in one case contained in a basin of water, in another introduced into the bladder of a dog previously distended with water, was completely disintegrated by voltaic electricity, from a battery of 120 pairs. The wires were introduced through a canula into the bladder. The operation, it is said, did not occasion the least apparent uneasiness to the animal. During the action of the battery on the calculus, the bases and phosphoric acid first arrived at their respective poles, then re-entered into combination, forming a pulverulent salt. Bonnet proposed to inject the bladder with a solution of nitrate of potash, and to galvanize the calculus in this liquor. The nitrate will be decomposed; the phosphates dissolve in the liberated nitric acid,—and uric acid, or urate of ammonia, in the disengaged potash. These propositions are ingenious, but at present no practical use has been made of them.

5. *To coagulate the blood within an aneurismal tumour.*—If the electrodes of a voltaic apparatus be immersed in an albuminous liquor, the albumen is coagulated. It has, therefore, been suggested "that galvanism might be applied to the important purpose of coagulating the blood within an aneurismal tumour, and thus removing the disease without resorting to the ligature[i]." For this purpose two needles are to be introduced into the tumour, and their projecting extremities connected with the opposite electrodes of the battery.

6. *To cauterize.*—Pravaz[k] has proposed to cauterize the bites inflicted by rabid animals, by introducing the electrodes of a battery into the wound. Fabré-Palaprat[l] has proposed to produce the cauterizing effects of the moxa by voltaic electricity: this kind of therapeutical agent he calls a *galvanic moxa*.

7. *To promote the absorption of medicinal substances.*—In 1832, Dr. Coster[m], and in 1833, M. Fabré-Palaprat[n], employed voltaic electricity to assist the introduction of certain medicinal substances into the blood. They adopted Sir H. Davy's[o] opinion (subsequently shown by Mr. Faraday[p] to be erroneous), that the poles (*electrodes*) of a voltaic battery have attractive and repulsive powers for certain substances: the positive pole (*anelectrode*) for oxygen, chlorine, and iodine,—the negative pole (*cathelectrode*) for hydrogen and the metals. M. Fabré-Palaprat asserts, that by the aid of galvanism he has caused certain chemical agents to traverse the body, and

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[g] See *Phil. Trans.* 1817, p. 22; and Dr. Wilson Philip's *Treatise on Indigestion.*—Also, La Beaume, *On the Medical Effects of Electricity and Galvanism in Nervous and Chronic Disorders.* 1820.

[h] *Journal de Physiologie*, t. iii. p. 217.

[i] Apjohn, *Cyclopædia of Practical Medicine*, art. *Galvanism*.

[k] *Revue Médicale*, Dec. 1830.

[l] *Du Galvanisme appliqué à la Médecine*, p. 57. Paris, 1828.

[m] *Archives Générales de Médecine*, t. ii. p. 432.

[n] Ibid. IIme série, t. ii.—Also, Becquerel, *Traité de l'Electricité*, t. iv. p. 321.

[o] *Phil. Trans.* 1807, p. 1.

[p] Ibid. 1838 and 1834.

appear at some distant part. He bound on one arm a compress, moistened with a solution of iodide of potassium, and covered by a platinum disk, connected with the negative pole (*cathelectrode*) of a voltaic battery of thirty pairs of plates. On the other arm was placed a compress, moistened with a solution of starch, and covered by a platinum disk, connected with the positive pole (*anelectrode*) of the battery. In a few minutes the starch acquired a blue tinge, shewing that the iodine had been transported from one arm to the other. But Davy's idea that the poles (*electrodes*) possess attractive and repulsive properties is not correct, as I have before remarked. That electricity may promote absorption, either by increasing endosmosis or by acting as a stimulus to the blood-vessels and lymphatics, is not improbable; but that the poles (*electrodes*) can draw medicinal substances either into or out of the body is not true. I have twice repeated Fabré-Palaprat's experiment; but, though I employed fifty pairs of plates for fifteen minutes, I was unable to obtain the slightest evidence of the passage of iodine through the body.

Electro-Puncture.

(Galvano-Puncture.)

The operation of electro-puncture was proposed by Sarlandière[q], in 1825. It consists in introducing two acupuncture needles in the usual way, and connecting them with the poles of a weak voltaic battery; the contact being occasionally suspended and renewed, in order to produce a succession of shocks. This practice has been successfully adopted for the relief of rheumatism, neuralgia, local paralysis, sciatica, spasmodic affections, and other maladies in which the operation of simple acupuncture has been used, than which it has been thought, by some, to be more efficacious. In neuralgia and in rheumatism it should be employed only in the interval of the paroxysms[r]. M. Bourgeois[s] proposed to employ the operation of electro-puncture of the heart, to promote resuscitation, in cases of asphyxia.

γ. *MAGNETIC ELECTRICITY.*

The apparatus required for the medical application of magnetic electricity consists of—

1. A magneto-electric machine.
2. A pair of directors.

The most convenient, simple, and powerful magneto-electric machine is that devised by Mr. E. M. Clarke, of the Strand. It consists of a battery of six curved permanent magnets, and an intensity armature, around whose cylinders 1500 yards of fine insulated copper wire are coiled. The ends of this wire communicate respectively with a pair of directors, each holding a piece of sponge (dipped in vinegar or a solution of common salt). When the armature is rotated, and a portion of the living body interposed between the directors, a succession of shocks is received.

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[q] *Mémoires sur l'Electro-puncture.* Paris, 1825.

[r] Trousseau and Pidoux, *Traité de Thérapeutique*, t. i. p. 579. Paris, 1836.

[s] Quoted by Merat and De Lens, in the *Dict. Univ. de Mat. Méd.* art. *Electro-Puncture.*

A magneto-electric machine is not affected by the moist state of the atmosphere: this gives it an advantage over the common electric machine; and as acids are not required to excite it, one inconvenience of the voltaic battery is obviated.

It is employed in medicine as a convenient substitute for the ordinary voltaic battery.

4. MAGNETISMUS.—MAGNETISM.

(Mineral Magnetism.)

Ætius[t], who lived about A. D. 550, is the oldest author who mentions the application of magnetism to the cure of diseases; for, although Hippocrates[u] speaks of the magnet as a remedial agent, he refers to its internal use only. About the end of the 17th century, magnetic tooth-picks and ear-picks were made as secret preventives against pains in the teeth, eyes, and ears[v].

The power of a magnet to affect the vital functions is not generally admitted in this country; but it must be remembered that the experience which British practitioners have had of its use is exceedingly limited. Becker says that the sensations which his patients experienced from the use of the magnet were, *cold* (probably from the coldness of the steel); *heat* (this is the most frequent effect, especially in the ears, and it often amounts to unpleasant burning); *traction* (from the slightest degree, when it is an agreeable feeling, to the strongest, when it is almost painful, like that of a cupping-glass); *an indefinite sensation* (in the ear, called a working or roaring); *throbbing; pain;* and *numbness* or *loss of feeling in the magnetised part.* Some years ago, Mr. Faraday allowed Dr. Keil to try his magnets, in every way he thought proper, on himself (Mr. F.), but without any effect resulting[w]. In some instances it has appeared to exercise a most remarkable influence over neuralgic pains and spasmodic affections; at one time apparently curing, at another palliating, and occasionally augmenting all the patient's sufferings. But, in a large proportion of cases, it fails to produce any obvious effect. The employment of magnetic plates is sometimes attended with itching and an eruption of pimples. Toothache, neuralgia, painful affections of the stomach, rheumatic pains, spasmodic asthma, angina pectoris, and palpitation of the heart, are the maladies which have occasionally appeared to be relieved by the magnet..

It is said that, in some cases, neuralgic pain is alleviated by the application of the north pole of the magnet, but is augmented by the south pole[x]. Laennec[y] speaks highly of the efficacy of magnetised plates in neuralgia of the lungs and in angina pectoris. He applied two strongly magnetised oval steel plates, one to the left precordial region, the other exactly opposite on the back, so that their poles were opposed. He says the relief is increased if a blister be applied under the anterior plate. The late Dr. Thomas Davies[z] tried this plan, and with good effect.

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[t] *Sermo* ii. p. cap. 25.

[u] *Opera; De intern. affect.* p. 543; and *De his quæ uterum non gerunt*, p. 686, ed. Fœsii.

Beckmann, *History of Inventions and Discoveries*, vol. i. p. 74.

Lancet for 1835-36, vol. i. p. 716.

Ibid. 1832—33, vol. ii. p. 312.

[y] *A Treatise on the Diseases of the Chest*, translated by Dr. Forbes, pp. 402 & 693. Lond. 1827.

There are several modes of using magnets. For toothache, a *simple straight* or *bar magnet*, sometimes called *a magnetic staff*, is used. It is first made warm, and its north pole applied to the tooth: if the pain be not relieved, the south pole should then be substituted. Or the poles are applied to, or passed over, the gums or cheeks. In neuralgic pains, *a compound magnet*, called *a magnetic battery*, is commonly employed. This consists of several curved (horse-shoe, lyre-shaped, or U-shaped) magnets, placed one over the other, with all their poles similarly disposed, and fastened firmly together. Dr. Schmidt[a] employed a battery of five magnets of unequal length, the centre one being the longest and thickest. This kind of battery is usually called by workmen *a magnetic magazine*. *Magnetic collars*, *girdles*, *bracelets*, &c. are made of several artificial magnets, with their opposite poles in contact, inclosed in linen or silk. *Magnetised steel plates* (*magnetic plates*), of various forms, are fitted to any part of the body. They are applied to the naked skin, and worn by the aid of a bandage[b].

To attempt to explain the *methodus medendi* of an agent whose therapeutical influence is not generally admitted, appears to me somewhat premature. I may remark, however, that should the existence of *electro-vital* or *neuro-electric* currents in the animal body, as announced by Prof. Zantedeschi and Dr. Favio[c], be hereafter fully established, we shall have a ready explanation of the medicinal power of magnetism in the well-known influence of a magnet over a voltaic current[d].

II. AGENTIA HYGIENICA.—HYGIENIC AGENTS.

(Non-Naturals.)

Under the absurd name of the *Non-Naturals* (*Non-Naturalia*), the ancients included six things necessary to health, but which, by accident or abuse, often became the cause of disease;—viz. *Air*, *Aliment*, *Exercise*, *Excretions*, *Sleep*, and *Affections of the Mind*[e]. These are now denominated *Hygienic Agents*[f].

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[z] *Lectures on the Diseases of the Lungs and Heart*, p. 497. Lond. 1835.

[a] *Lancet* for 1835-36, vol. i. p. 338.

[b] Figures of the different forms of magnetic instruments here referred to, are given by MM. Andry and Thouret, in their very elaborate and able article on Medical Magnetism, in the *Mémoires de la Société Royale de Médecine*, Année 1779, p. 531.

[c] *Report on the Memoir on Electric Currents in Warm-blooded Animals*, by Prof. Zantedeschi and Dr. Favio, presented to the Royal Academy of Sciences of Brussels on the 4th April, 1840. By M. Cantraine. In *Lond. Edinb. and Dub. Phil. Mag.* for April, 1841.

[d] For further information respecting Magnetism as a therapeutical agent, I must refer to Andry and Thouret's Memoir before quoted; as also to Dr. Becker's *Der mineralische Magnetismus und seine Anwendung in der Heilkunst*, Mühlhausen, 1829; Dr. Bulmerincq's *Beiträge zur ärztlichen Behandlung mittelst des mineralischen Magnetismus*, Berlin, 1835; and Dr. Schnitzer's *Ueber die rationelle Anwendung des mineralischen Magnetismus*, Berlin, 1837.—Also, Most's *Encyklopädie der gesammten medicinischen und chirurgischen Praxis*; art. *Magnetismus mineralis*. 2er Band. S. 394. Leipzig, 1837.

[e] For an account of the Non-Naturals, consult Sutherland's *Attempts to revive Antient Medical Doctrines*, vol. ii. p. 113. Lond. 1763.—Also, Willich's *Lectures on Diet and Regimen*, 3rd. edit. Lond. 1800.

[f] Rostan (*Dict. de Médecine*, art. *Hygiène*) terms them *Matière de l'Hygiène.*—On Hygiène, consult Dunglison, *On the Influence of Atmosphere and Locality; Change of Air and Climate; Seasons; Food; Clothing; Bathing; Exercise; Sleep; Corporeal and Intellectual Pursuits, &c. &c. on Human Health; constituting Elements of Hygiene.* Philadelphia, 1835.

I propose very briefly to consider, as therapeutic agents, *Food*, *Climate*, and *Exercise*. *Affections of the Mind* have been already noticed[g].

1. CIBUS.—FOOD.

The substances employed as Food (*Cibus*) may be conveniently arranged in three groups, respectively denominated Aliments (*Alimenta*), Drinks (*Potulenta*), and Condiments (*Condimenta*).

a. *ALIMENTA.—ALIMENTS.*

It will be convenient to consider aliments under the two heads of *Alimentary Principles* and *Compound Aliments*[h].

1. ALIMENTARY PRINCIPLES.

Dr. Prout[i] has divided the alimentary principles into three great classes or groups—the *saccharine*, the *oleaginous*, and the *albuminous*. He was led to this division by observing that milk, the only article actually furnished and intended by nature as food, always contains a saccharine principle, a butyraceous or oily principle, and a caseous, or, more correctly speaking, an albuminous principle. This arrangement of alimentary principles appears to me to be superior to any hitherto devised; and I shall, therefore, adopt it.

CLASS 1.—Saccharine Principles.

The principles contained in this class are Sugar, Gum, Vegetable Jelly, Starch, and Lignin. These agree in being of vegetable origin, and in consisting of carbon, hydrogen, and oxygen. With the exception of pectin or vegetable jelly, they contain oxygen and hydrogen in the ratio to form water; and might, therefore, be termed *hydrates of carbon*. The following table is principally drawn up from Dr. Prout's paper in the Philosophical Transactions before referred to :—

	Carbon.	*Water.*	
SUGAR,			
Pure Sugar Candy..	42·85	57·15	
Impure ditto......	41·5 to 42·5	58·5 to 57·5	
East India ditto....	41·9	58·1	
English refined....	41·5 to 42·5	58·5 to 57·5	
East India refined .	42·2	57·8	
Maple	42·1	57·9	
Beet-root..........	42·1	57·9	
East India moist ..	40·88	59·12	
Diabetic	36 to 40 ?	64 to 60 ?	
Of Narbonne Honey	36·36	63·63	
Of Starch	36·2	63·8	
Of Milk	40·0	60·0	
GUM,			
Arabic	36·3	63·7	
Ditto, dried at 212°	41·4	58·6	
STARCH,			
Fine Wheaten	37·5	62·5	
Ditto, dried at 212°	42·8	57·2	
Ditto, highly dried at 350°	44·0	56·0	
Arrow-root	36·4	63·6	
Ditto, dried at 212°	42·8	57·2	
Ditto, highly dried at 212°	44·4	55·6	
LIGNIN,			
From Box	42·7	57·3	
Ditto, dried	50·0	50·0	
From Willow	42·6	57·4	
Ditto, dried	49·8	50·2	
PECTIN OR VEGETABLE JELLY,		*Hydr.*	*Oxyg.*
From sweet apples (Mulder[hh]).............	45·198	5·352	49·450
Ditto, sour ditto (ditto)	45·853	5·479	48·668
In pectinate of lead (ditto)	45·608	5·370	49·022
In pectinate of lead (Fremy[ii])	43·5	5·2	51·4

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[g] See p. 2.

[h] See Tiedemann's *Untersuchungen über das Nahrungs-Bedürfniss, den Nahrungs-Trieb, und die Nahrungs-Mittel des Menschen.* Darmstadt, 1836.

[i] *Phil. Trans.* for 1827, p. 355. Also, *On the Nature and Treatment of Stomach and Urinary Diseases*, 3d edit. Lond. 1840. In the latter work he admits a fourth alimentary principle, which he calls *aqueous.*

[hh] *Pharm. Central-Blatt für* 1838, p. 338.

[ii] *Journ. de Pharm.* xxvi. 373.

Those varieties of each principle which contain the smallest quantity of water, Dr. Prout terms *strong* or *high;* while those containing the largest proportion of water, he denominates *weak* or *low.* Thus sugar-candy is a high or strong sugar,—sugar of starch, a weak or low one.

Sugar is the only one of the above five principles capable of crystallizing; and is, therefore, the farthest removed from organization and life. Gum, though incapable of crystallizing, is not organized: it may be denominated an organizable substance. Starch and lignin are organized substances.

In *Diabetes,* abstinence from all the alimentary principles of this class is attended with a considerable diminution of the saccharine secretion. Farinaceous matter, though less objectionable than common sugar, is readily convertible into sugar.

1. SACCHARINA. *Saccharine Substances.*—Under this head are placed several sweet organic principles, capable, for the most part, of undergoing vinous fermentation when mixed with yeast and a due proportion of water.

a. SUGARS SUSCEPTIBLE OF VINOUS FERMENTATION.

1. *Crystallizable.* This division includes *common sugars* (viz. *cane, maple,* and *beet-root sugars*), *granular sugars* (viz. *grape, honey, starch,* and *diabetic sugars*), and *sugar of milk.*
2. *Uncrystallizable.* Called *liquid* or *mucous sugars,* as *treacle.*

b. SUGARS UNSUSCEPTIBLE OF VINOUS FERMENTATION[j].

1. *Crystallizable. Mannite.*
2. *Uncrystallizable. Glycyrrhizin, Glycerin,* and *Sarcocollin.*

Sugar is a highly nutritious substance, and by the healthy stomach is readily digested. It does not agree, however, with some dyspeptics. Flatulency and preternatural acidity of stomach are frequently ascribed to it; but, in many cases, these conditions are referrible rather to the substances taken with the sugar, than to the saccharine matter itself. In diabetes the power of assimilating sugar is in a great measure lost, and the dietetical use of saccharine matter must be rigorously prohibited.

Sugar appears to contribute directly to the nutrition of plants: for the saccharine juices of the sugar-cane, of the maple, of the beet-root, &c. must be regarded as nutritive. Yet, it is somewhat remarkable, and apparently inconsistent with this statement, that saccharine matter is found in the excretions of plants; as those formed by the nectariferous glands. Sugar appears to be especially adapted for the food of young plants; hence we find it generated in many seeds (as peas, barley, &c.) during germination.

It is nutritive to animals. Thus it is an important constituent of milk;—a liquid intended for the nourishment of mammals during the first period of their existence. Many insects (especially the *Lepidoptera, Hymenoptera,* and *Diptera*) feed on sugar or saccharine liquids. Its asserted poisonous action on some *Annelida,* birds, and frogs, is improbable, and wants confirmation[k]. That a diet of sugar only is incapable of supporting the life of mammals and birds, has been fully proved by the experiments of Magendie[l] and of Tiedemann and Gmelin[l]. Dogs and geese die, when confined and fed solely on sugar and water, with all the symptoms of starvation. Change or alteration of diet, with the use of a certain portion of nitrogenous food, seems, therefore, to be essential to the vitality of these animals.

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[j] Liebig (Turner's *Elements of Chemistry,* 7th ed. p. 914, Lond. 1840) regards those substances only as saccharine which are susceptible of the vinous fermentation.

[k] Vide Murray, *App. Med.* vol. v. p. 411. Goett. 1790.

[l] *Ann. de Chim.* iii. 66. 1816.

Sugar is employed by man on account of its agreeable taste, rather than as a direct source of nourishment; yet, of its nutritive qualities, few entertain any doubt. During the sugar season of the West India Islands, "every negro on the plantations, and every animal, even the dogs, grow fat[m]." The injurious effects, which have been ascribed to sugar, are more imaginary than real. Some individuals have consumed large quantities of it, for a long series of years, without suffering any ill consequences[n]. Stark's experiments[o] hardly admit of any legitimate conclusions being drawn therefrom, as to the action of sugar. The fondness of children for sugar may be regarded as a natural instinct; since nature, by placing it in milk, evidently intended it to form a part of their nourishment during the first period of their life. The popular notion of its having a tendency to injure the teeth seems most absurd, as Dr. Slare[p] has shewn. "It has been alleged, that the eating of sugar spoils the colour of and corrupts the teeth: this, however, proves to be a mistake, for no people on the earth have finer teeth than the negroes in Jamaica[q]."

The principal use of sugar, considered *dietetically*, is for sweetening various articles of food, whose nutritive qualities also it promotes. In diabetes, and the oxalate of lime diathesis, sugar and sweet foods should be rigorously excluded. In dyspepsia, its effects are to be carefully examined; and, if found to be injurious, its use ought to be prohibited. The copious use of unrefined sugar is likely to prove injurious in some nephritic disorders, as the phosphatic diathesis, on account of the lime contained in it.

2. Mucilaginosa. *Gummata.*—The gummy principles, called Arabin, Tragacanthin or Adraganthin, Cerasin or Prunin, Cydonin, and Bassorin, belong to this group. They possess nutritive properties; but are somewhat difficult of digestion, and apt to disagree with dyspeptics.

Magendie[r] has shewn that dogs, fed on gum alone, languish and die in two or three weeks; and Tiedemann and Gmelin[s] found, that a goose, fed with gum, died on the sixteenth day. These, as well as other experiments, merely shew, however, that animals require more than one kind of aliment.

The nutritive property of gum is shown by several facts. In the first place it constitutes a portion of several well-known articles of food; secondly, it sometimes forms the principal or only food of man. Hasselquist[t] tells us, that a caravan, of more than a thousand persons, travelling from Abyssinia to Cairo, and whose provisions were exhausted, supported themselves for two months on the gum they were carrying as merchandize. The Moors and the Negroes near the Niger, employ it as a common kind of food. The Hottentots also each are well aware of its nutritive properties[u]. Six or eight ounces daily for an adult are said to be sufficient to sustain life.

3. Vegeto-Gelatinosa. *Vegetable Jelly.*—To this head are referred Pectin or Grossulin, and Carrageenin. These are nutritive and digestible. Whether the tendency of some fruits to disorder the *primæ viæ* is fairly ascribable to the vegetable jelly, or to some other principle associated with it, has not been clearly made out.

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[l] Müller's *Elem. of Phys.* by Baly, p. 482.

[m] Wright, *Med. Plants of Jamaica.*

[n] Slare, *Vindication of Sugars*, Lond. 1715.

[o] Stark's *Work*, ed. by J. C. Smith, pp. 160 and 115. Lond. 1788.

[p] *Op. cit.*

[q] Wright, *op. cit.*

[r] *Ann. de Chim. et Phys.* t. iii. p. 66.

[s] Müller's *Physiology*, by Baly, vol. i. p. 482.

[t] *Voyages and Travels in the Levant*, p. 293. Lond. 1766.

[u] Murray, *App. Medicam.* vol. ii. p. 535. Ed. alt. Goett. 1794.

Pectin, under the influence of an alkali, is readily converted into pectic acid. The latter has been recommended for the formation of jellies, gelatinous conserves[f], &c.

4. FARINOSA. *Amylaceous, farinaceous, or starchy substances.*—Under this division are included Wheat-starch, Sago, Tapioca, Arrow-root (West Indian, East Indian, South Sea, and Portland), Potato-starch, Tous les Mois, Salop, &c. Amylaceous matter is found in various parts of plants. The albumen of the seeds of grasses abound in it, and from this organ wheaten- and rice-starch are obtained. The fleshy cotyledons of the leguminous seeds—as peas and beans—likewise contain it. In the roots, subterranean stems, and tubers of many plants, it is also found; and from these sources are procured Tapioca, Arrow-root (West Indian, East Indian, and Portland), Salop, Potato Starch, and Tous les Mois. The interior of some monocotyledonous stems abound in farinaceous matter; and from this source Sago is obtained. Furthermore, a feculoid substance, called *lichenin*, is found in some Lichens—as in Cetraria islandica.

The amylaceous substances are organized. Examined by a microscope they are seen to consist of small grains, which are usually rounded, or elliptical, or mullar-shaped, or polyhedral. The polyhedral form probably arises from the mutual compression of numerous grains in the same or neighbouring cells. On some part of the surface of each grain is a round spot, called the hilum: very rarely, two or even three of these spots are observed on the same grain. The grains of most, if not of all, feculas, have a laminated texture. To the concentric layers is owing the appearance of concentric rings on the surface of most feculas[g]. The organic principle (*amidon*), of which these layers consist, seems to be uniform in its composition and properties, excepting in some slight differences of cohesion[h].

When cooked, amylaceous matter is a nutritious and easily digestible substance. Directly or indirectly, observes Dr. Prout[i], "it forms a constituent of the food of most of the higher animals, as well as of man. It differs, therefore, from sugar, in being a *necessary* article of food, without which animals could not exist; while sugar is not. Hence a much larger quantity of amylaceous matter than of sugar, can be taken; and what is a still more decisive fact, the use of this larger quantity of amylaceous matter may be persisted in for an unlimited period, which, it appears, is not the case with a large proportion of sugar."

Farinaceous food is, perhaps, the least irritating of all kinds of aliments. It is, therefore, well adapted for the use of persons affected with morbidly sensible conditions of the primæ viæ. It will sometimes remain on the stomach when every other kind of nutriment is immediately rejected. Being totally devoid of all stimulating properties, it is a useful and valuable article of food in febrile and inflammatory diseases. In diabetes it is the only kind of vegetable aliment admissible.

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[f] Dumas, *Traité de Chimie*, t. v. p. 404. Paris, 1835.

[g] Figures of the different starchy bodies, drawn to the same scale, will be given in subsequent parts of this work (see *Index*).

[h] For an elaborate account of the structure and chemical properties of starchy substances, see Payen's *Mémoire sur l'Amidon*, in the *Annales des Sciences Naturelles*. 2nde Série, t. x; Botanique. Paris, 1838.

[i] *On the Nature and Treatment of Stomach and Urinary Diseases*, p. x. Lond. 1840.

To render amylaceous matter digestible, it requires to be cooked in order to break or split the grains; for, of the different laminæ of which each grain consists, the outer ones are the most cohesive, and present the greatest resistance to the digestive power of the stomach, while the internal ones are the least so. Hence farinaceous substances are boiled in milk or water,—or they are panified with gluten, by which the grains are completely broken up[j],—or they are made into puddings and tarts.

5. LIGNIN. *Woody Fibre.*—The substance, called lignin, constitutes the basis of woody fibre, vessels, ducts, and cellular tissues of plants. Its composition is probably similar in all plants[k]. It "forms the appropriate food of numerous insects and of some of the lower animals, but of few of the higher classes of animals. The reason of this is probably to be sought for, in their not being furnished with organs proper for comminuting and reducing it; for when lignin is comminuted and reduced by artificial processes, it said to form a substance analogous to the amylaceous principle, and to be highly nutritious[l]."

The Laplanders, according to Linnæus[m], eat bark-bread (*barkbröd*) during a great part of the winter, and sometimes even during the whole year. It is prepared from the inner bark of the *Pinus sylvestris*[n].

Professor Autenrieth[o], of Tubingen, states, that when wood is deprived of every thing soluble, reduced to powder, repeatedly subjected to the heat of an oven, and then ground in the manner of corn, it yields, boiled with water, a flour, which forms a jelly, like that of wheat-starch, and, when fermented with leaven, makes a perfectly uniform and spongy bread.

CLASS 2.—Oleaginous Alimentary Principles.

This class comprehends the substances denominated Fats, Fixed Oils, and Butters.

Dr. Prout[p] includes also the volatile oils. But, though volatile oil is a constituent of several substances employed as aliments or condiments, yet I am unacquainted with any evidence of its being alimentary. When received into the stomach, it is absorbed, and taken into the system; but is subsequently thrown out again, without having undergone much, if any, change. Alcohol, which Dr. Prout ranks with the volatile oils, is neither oleaginous nor alimentary.

The ultimate constituents or the elementary principles of the oleaginous substances are Carbon, Hydrogen, and Oxygen. The proportions are as follow:—

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[j] Good bread gives not the slightest trace of entire grains of starch.

[k] According to the Rev. J. B. Reade (*Lond. & Edin. Phil. Mag.* vol. xi. p. 421), a very remarkable difference exists between the chemical composition of cellular membrane and of spiral vessels in the same plant. But his "results are in many respects so remarkably at variance with all that we are as yet acquainted with respecting similar subjects, that we must at the outset doubt their correctness." (Meyen's *Report on the Progress of Vegetable Physiology, during the year* 1837. Translated by Wm. Francis. Lond. 1839.)

Prout, *op. ante cit.* p. xii.

[m] *Flora Lapponica.*

[n] See Von Buch in *The Scots Magazine*, vol. lxxx. p. 315. Edinb. 1817.

[o] *Phil. Trans.* 1827, p. 355.—Also, *The Scots Mag.* vol. lxxx. p. 313.

[p] *Op. supra cit.* p. xiv.

	Carbon.	*Hydrogen.*	*Oxygen.*	*Loss.*
Almond Oil (Saussure[q])	77·403	11·481	10·828	0·288
Olive Oil Elaine (Saussure)	76·034	11·545	12·068	0·353
Margarine (Saussure)	82·170	11·232	6·302	0·296
Butter (Bérard[r])	65·6	17·6	16·8	—
Hog's Lard (Chevreul[s])	79·098	11·146	9·756	—
Mutton Suet (Chevreul)	78·996	11·700	9·304	—

The fats and fixed oils, as presented to us by nature, are separable into two or three or more fatty principles; of which stearine, margarine, elaine, and butyrin, are the most important. By subjecting solid or congealed fats to pressure, Braconnot[t] separated several of them into two parts,—the one liquid (elaine), the other solid (stearine and margarine.)

	Stearine.	*Elaine.*
Butter	40	60
Hog's Lard	38	62
Beef Marrow	76	24
Mutton Marrow	26	74
Goose Fat	32	68
Duck Fat	28	72
Turkey Fat	26	74

	Margarine.	*Elaine.*
Olive Oil	28	72
Almond Oil	24	76
Oil of Colza[u]	46	54

Stearine, Margarine, Elaine, and Butyrine, yield, by saponification, fatty acids, a sweet basic principle called glycerine (or the oxide of glycerule), and water. They are probably, therefore, hydrated salts of glycerine. The acids (stearic, margaric, and oleic) obtained respectively from stearine, margarine, and elaine, are fixed; while those (butyric, capric, and caproic acids) procured from butyrin, are volatile and odorous.

Oleaginous aliments are highly nutritious, but exceedingly difficult and slow of digestion. The last-mentioned circumstance is familiar to every dyspeptic, and has been confirmed by the experiments of Dr. Beaumont[v], made on a Canadian, who had, two inches below the left nipple, a permanent artificial opening into his stomach, produced by a gun-shot wound. Dr. Beaumont remarks, that the bile is not ordinarily found in the stomach; but that, after the use of oily food, it is often observed there: and, he concludes, that it assists the digestion of the fatty substances. The operation of heat on the fatty bodies is injurious to their digestibility, especially in the case of butter. This appears to be owing to the development of acrid fatty acids, and empyreumatic oily matters. Hence buttered toast, melted butter, substances cooked by frying in oil or butter, and pastry, are highly injurious to dyspeptics.

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[q] *Ann. de Chim. et Phys.* t. xiii. p. 351.

[r] Gmelin, *Hand. d. Chemie*, Bd. ii. S. 439.

[s] Ibid.

[t] *Ann. de Chim.* xciii. 225. Braconnot terms all the solid fats, stearine; but Lecanu (*Ann. de Chim. et Phys.* lv. 192) has shown that the solid fat of the vegetable oils is margarine.

[u] The Colza is the *Brassica campestris*, which is closely allied to *Brassica Napus*, the seeds of which yield Rape Oil.

[v] *Experiments and Observations on the Gastric Juice and the Physiology of Digestion.* By Wm. Beaumont, M.D. Reprinted from the Plattsburg edition, with notes by Dr. Combe. Edinb. 1838.

Oleaginous foods often agree so remarkably well with diabetic patients, "that some have gone so far as to propose them as remedies. When freely taken, they usually cause a flow of saliva, and thus diminish the urgent thirst. When they agree, also, they give a sensation of satisfaction and support to the stomach, which other alimentary substances do not. Perhaps butter is the most agreeable form in which they can be taken, and this, under proper circumstances, may be taken freely. When oleaginous matters disagree, as is sometimes the case, they should be carefully shunned[w]."

Sir John Ross[x] considers, and his opinion is probably correct, that the natives of cold countries seem to require a more fatty diet than the inhabitants of tropical regions, in order to promote the production of animal heat.

Class 3.—Nitrogenous or Azotized Alimentary Principles.

(Albuminous Aliments, *Prout.*)

The most important alimentary principles, containing nitrogen or azote, are Fibrine, Albumen, Caseum, Gelatine, and Gluten. The animal extract, called Osmazome, is also a nitrogenous principle. With one exception (Gluten), these principles are obtained from the animal kingdom, and they have, in consequence, been frequently denominated *animal* aliments. They are composed of carbon, hydrogen, nitrogen, and oxygen, in the following proportions:—

	Carbon.	Hydrog.	Nitrogen.	Oxygen.
FIBRINE of a Cow's Arterial Blood (Mulder[y])	53·019	6·828	15·462	24·691
of ditto Venous Blood (Mulder)	53·476	6·952	15·291	24·281
of Muscle of the Ox (Sass & Pfaff[z])	48·30	10·64	15·92	17·64 & fixed salts 7·50
ALBUMEN of Eggs (Mulder)	53·960	7·052	15·696	23·292
of Arterial Blood (Michaelis[a])	53·009	6·993	15·562	24·436
of Venous Blood (Michaelis)	52·650	7·359	15·505	24·484
CASEUM (Jul. Vogel[b])	52·53	7·82	16·20	23·45
GELATINE of Hartshorn (Mulder)	50·048	6·477	18·350	25·125
of Isinglass (Mulder)	50·757	6·644	18·313	24·286
GLUTIN (Boussingault[c])	54·0	7·50	14·60	23·90

In *Diabetes*, the diet should be principally of nitrogenous principles. Dr. Rollo[d] advocated the exclusive use of animal substances in this malady, and, of its power to check the secretion of sugar, no doubt seems to be entertained. But the craving for vegetable food which some patients experience is so great, that considerable difficulty is experienced in inducing them to submit to a diet exclusively animal. Moreover, violent fever has been ascribed to it[e]. Hence the recommendation of Dr. Prout, to allow a certain quantity of farinaceous food, has been very generally assented to and followed. More recently, however, Dr. Christison[f] has published some cases, showing that a mixed diet of animal and vegetable food is sometimes inadmissible; and "that if a sensible amelioration is to be looked for with any confidence, the injunctions of Rollo and his imitators, to enforce a rigorous animal diet, must often be faithfully followed."

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[w] Prout, *op. supra cit.* p. 43.

[x] *Narrative of a Second Voyage in Search of a North-West Passage*, p. 201. Lond. 1835.

[y] *Pharmaceutisches Central-Blatt für* 1837, S. 325.

[z] Müller's *Elements of Physiology*, by Baly, vol. i. p. 369. I strongly suspect some error in this analysis.

[a] Berzelius, *Traité de Chimie*, t. vii. p. 75.

[b] *Pharm. Central-Blatt für* 1839, S. 491.

[c] *Ann. de Chim. et Phys.* lxiii. 229.

[d] *An Account of two Cases of Diabetes Mellitus*, Lond. 1797.—*Cases of the Diabetes Mellitus*, Lond. 1798. 2d ed. with large additions, 1806.

[e] See the statements of Dr. Marsh, in the *Dublin Hospital Reports*, vol. iii. Dubl. 1822; and of Dr. Prout, in his *Inquiry into the Nature and Treatment of Diabetes, Calculus, and other Affections of the Urinary Organs*, p. 79. Lond. 1825.

In the *Oxalic Acid Diathesis*, the plan of diet is the same as for Diabetes.

1. Fibrine.—In the liquid form, or in the state of suspension, it exists in the blood. In the solid state it is the principal constituent of the muscles or fleshy parts of animals. It is eminently nutritious, and easy of digestion.

2. Albumen.—This principle constitutes the most important part of animal foods. In the liquid state it exists in eggs (*ovalbumen*) and the serum of the blood (*seralbumen*). In the solid or coagulated state it is a constituent of the flesh, glands, and viscera of animals. The chemical properties of coagulated albumen are almost identical with those of fibrine. Albumen is highly nutritious, and when either raw or lightly boiled is easy of digestion; but when boiled hard, or especially when fried, its capability of being digested is considerably impaired. (See *Eggs*, p. 59.)

3. Caseum. *Lactalbumen*, or *Curd.* — This is the coagulable matter of milk, and is closely allied to albumen, of which it may be regarded as a modification. Coagulated, dried, somewhat changed in its nature, and more or less mixed with butter, it constitutes *cheese*. It is nutritious, and moderately easy of digestion.

4. Gelatine. *Animal Jelly.*—Gelatine is obtained by boiling certain animal tissues in water: the concentrated decoction forms, on cooling, a tremulous mass, called *jelly*. The bones, antlers, skin, tendons, and aponeuroses of mammals, and the swimming bladder of fishes, are the especial sources of it. It is an exceedingly nutritive principle, though probably somewhat less so than fibrine and albumen. As far as my own observations extend it is readily digestible; but it is said not to be suited to the digestive powers of many dyspeptics.

"Gelatine may be considered as the least perfect kind of albuminous matter existing in animal bodies; intermediate, as it were, between the saccharine principles of plants, and thoroughly developed albumen. Indeed, gelatine in animals may be said to be the counterpart of the saccharine principles of plants; it being distinguished from all other animal substances, by its ready convertibility into a sort of sugar, by a process similar to that by which starch may be so converted[g]."

Gelatine from Bones is employed in Paris for the preparation of a nutritious soup for hospitals and other pauper habitations[h].

Hartshorn Jelly is principally used by invalids.

Patent Gelatine is procured from the skins of animals[i].

Confectioner's Jelly is made from isinglass, calves' feet, and patent gelatine.

Soups and *Broths* owe their nutritive properties principally to gelatine.

Young meats yield more gelatine than old ones.

The *Sounds* of fish and *Isinglass* are gelatinous substances.

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[f] *Edinb. Monthly Journal of Medical Science* for April, 1841.

[g] Prout, *On the Nat. and Treatm. of Stomach and Urinary Diseases*, p. xiii.

[h] D'Arcet, *Recherches sur les Substances nutritives que renferment les Os.* Paris 1829.—Edwards and Balzac, in the *Annals des Sciences Nat.* Juillet 1832, p. 318.—Also, Edwards' *Recherches Statistiques sur l'Emploi de la Gélatine.* Paris, 1835.

[i] See *The Mechanic and Chemist* of July 4th, 1840. Lond.

5. Osmazome. *Alcoholic Extract of Meat.*—This is an alcoholic extract obtained from the flesh, brain, and other parts of animals. It has a reddish brown colour, and the smell and taste of soup. It is generally mixed with lactic acid, the lactates, and common salt. To this principle broths and soups owe their flavour, smell, and part of their nutritive qualities.

6. *Gluten.*—This substance is found in corn; especially in wheat. By washing wheaten dough with a stream of water, the gum and the sugar are dissolved, the starch is washed away, while the gluten is left in the form of a ductile, tenacious, elastic, grey mass, which, by the action of alcohol, is resolved into *albumen*, *mucin*, and *gluten*.

a. *Albumen* is insoluble in alcohol, but soluble in water.
b. *Mucin* is soluble in boiling alcohol, but deposits as the liquid cools.
c. *Gluten* is soluble in alcohol, but is almost insoluble in water.

Gluten is believed to be highly nutritious, and to confer on wheat-flour its well-known superior alimentary qualities.

"It is the presence of gluten in wheaten flour that renders it pre-eminently nutritious, and its viscidity or tenacity confers upon that species of flour its peculiar excellence for the manufacture of *macaroni*, *vermicelli*, and similar pastes, which are made by a kind of wire-drawing, and for which the wheat of the south of Europe, (more abundant in gluten than our own) is particularly adapted. The superiority of wheaten over other bread depends upon the greater tenacity of its *dough*, which, in *panary fermentation*, is puffed up by the evolved carbonic acid, and retained in its vesicular texture, so as to form a very light loaf[j].

2. Compound Aliments.

These we subdivide into animal and vegetable.

a. *Animal Aliments.*

We may conveniently arrange these in six classes;—viz.

1. Mammals.
2. Birds.
3. Reptiles.
4. Fishes.
5. Crustaceous animals.
6. Mollusks.

Class 1. Mammalia.—Mammals.

In this country, the mammals employed by man, as food, are the Ox, the Sheep, the Hog, the Deer, the Rabbit, and the Hare.

Herbivorous are generally preferred to carnivorous animals for food; as the flesh of the latter has a somewhat disagreeable odour.

Mammals furnish their flesh, their viscera, their blood, and their milk, as articles of food.

1. Flesh.—This consists principally and essentially of muscle, intermixed, however, with tendons, aponeuroses, nerves, vessels, cel-

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[j] Brande's *Manual of Chemistry*, p. 1091, 5th ed. 1841.

lular tissue, blood, serum, and fat. Its chemical constituents are fibrine (principally), albumen, gelatine, hæmatosin or the colouring matter of the blood, osmazome, fatty matter (stearine and elaine), creatine[k], a peculiar nervous matter, and salts. The following are the proportions of the three first principles in the muscles of some kinds of flesh[l]:—

100 *Parts of Muscle of*	*Water.*	*Albumen or Fibrine.*	*Gelatine.*	*Total of Nutritive Matter.*
Beef	74	20	6	26
Veal	75	19	6	25
Mutton	71	22	7	29
Pork	76	19	5	24

The flesh of young animals is more tender than that of old ones. That of castrated males is not only more delicate and finer grained, but has a more agreeable odour and flavour than that of the uncastrated animal. Spaying is said to improve the flavour of the flesh of the female. With regard to digestibility, Dr. Beaumont found that digestion is facilitated by minuteness of division and tenderness of fibre; and retarded by opposite qualities. Venison he ascertained to be one of the most digestible substances; a circumstance which he refers to its being easily divisible into shreds or small particles. Beef and mutton are also easy of digestion.

The following table shows the mean time of digestion of several kinds of flesh, according to Dr. Beaumont's experiments:—

	Hour.	*Minutes.*
Venison steak, broiled	1	35
Sucking pig, roasted	2	30
Lamb, fresh, broiled	2	30
Beef steak, broiled	3	0
Mutton, fresh, broiled	3	0
Pork steak, broiled	3	15
Veal, fresh, broiled	4	0
Beef, old, hard, salted, boiled	4	15

By boiling flesh in water, the fibrine is corrugated, the albumen coagulated (though, by a prolonged action of heat and water, it yields a soluble nitrogenous matter); the hæmatosine is also coagulated; the cellular tissue, the tendons, and the aponeuroses, yield gelatine; the fatty matters melt; while the osmazome and the creatine are dissolved[m].

2. VISCERA.—The brain, the liver, the spleen, the kidneys, the thymus[n], the lungs, and the alimentary canal of mammals[o], are employed as food. They abound principally in albumen.

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[k] Creatine (from κρέας, *flesh*) is a nitrogenous, crystallizable substance, insoluble in alcohol. It was discovered by Chevreul (*Journ. de Chim. Méd.* t. viii. p. 548).

[l] Brande, *op. supra cit.*

[m] See some interesting observations on the effects of heat and water on meat, in Soubeiran's *Nouv. Traité de Pharm.* t. i. p. 130. 2nde ed. Paris, 1840.

[n] The thymus of the calf is commonly termed *sweetbread*.

[o] The stomachs of ruminants, when prepared as food, constitute *tripe*.

Composition of the Liver of the Ox[p].

Vascular & Cutaneous Tissues	18·94
Parenchyma (*i. e.* soluble parts)	81·05
Liver	100·00

Brown oil, containing phosphorus	3·89
White fatty flocculi	?
Nitrogenous matter	6·07
Albumen	20·19
Blood	?
Salts	1·21
Water	68·64
Parenchyma of the liver	100·00

Composition of the Thymus of the Calf[q].

Albumen	14·00
Osmazome	1·65
Gelatine	6·00
Peculiar animal matter	0·30
Margaric acid	0·05
Fibrine	8·00
Water	70·00
Thymus	100·00

The following are the mean times of digestion of several viscera, according to Dr. Beaumont:—

	Hour.	*Minutes.*
Tripe, soused, boiled	1	0
Brains, animal, boiled	1	45
Liver of the ox, fresh, broiled	2	0

Sausages made of the flesh, viscera, or blood of animals, and cured by smoking, have sometimes acquired, by keeping, highly deleterious qualities, which Buchner ascribes to the presence of a peculiar fatty acid, which has been termed *botulinic acid* (Würst-fett-saüre[r]).

Bacon also sometimes becomes poisonous[s].

3. Blood.—Among civilized nations, the pig is the only animal whose blood furnishes a distinct article of food. Mixed with fat and aromatics, and enclosed in the prepared intestines, the blood of this animal constitutes the substance sold in the shops under the name of *black pudding* (*apexabo*).

The deleterious qualities, which blood puddings sometimes acquire, have been above referred to.

4. Milk.—Properly speaking, milk should be considered among Drinks; but, as it contains a large quantity of alimentary matter, and, furthermore, as it yields some solid foods (butter and cheese), it will be most convenient to consider it here. The composition of several kinds of milk is thus stated by MM. O. Henry and Chevallier[t]:—

	Milk of the				
Constituents.	*Cow.*	*Ass.*	*Woman.*	*Goat.*	*Ewe.*
Caseum	4·48	1·82	1·52	4·02	4·50
Butter	3·13	0·11	3·55	3·32	4·20
Sugar of Milk	4·77	6·08	6·50	5·28	5·00
Various Salts	0·60	0·34	0·45	0·58	0·68
Water	87·02	91·65	87·98	86·80	85·62
Total	100·00	100·00	100·00	100·00	100·00
Solid substances	12·98	8·35	13·00	13·20	14·38

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[p] Braconnot, *Ann. de Chim. et Phys.*, x. 189.

[q] Morin, *Journ. de Chim. Méd.* t. iii. p. 450.

[r] See Christison's *Treatise on Poisons*, p. 585. 3d ed. Edinb. 1835.

[s] *Ibid.* p. 592.

[t] *Journ. de Pharm.* t. xxv. p. 340.

The nutritive principles of milk are (excluding water),—caseum, butter, and sugar of milk. Perhaps the phosphate of lime, found in milk, ought to be considered as an aliment for young animals; inasmuch as it is necessary to the development of their osseous system. For the most part, milk is readily digestible; but, with adults, this is by no means universally the case. With some dyspeptics, it proves heavy and difficult of digestion. I find that those, with whom it disagrees, are obnoxious to the use of butter; whence I infer, that the injurious qualities of milk are ascribable to the oily constituent; and, with such patients, ass's milk (which contains but little butter) usually agrees.

The quantity of nutritive matter, contained in milk, varies not only with the species, but with the individual,—nay, with the same individual under different circumstances. The quality of the milk is affected by constitution, age, food, period after parturition, mental emotion, disease, the use of medicines, &c.

Dr. Young[t] found, that a bitch, fed on vegetable aliment, yielded an acescent and spontaneously coagulable milk; but, when animal food was substituted, the milk became alkaline, and did not spontaneously coagulate.

Dr. Cullen says, "I allege it to be a matter of experience, that, supposing the quantity of liquid to be the same, nurses living entirely, or for the greater part, upon vegetable aliment, afford a greater quantity of milk, and of a more proper quality, than nurses living upon much animal food. This I venture to assert—from the observations of fifty years."

The influence which many medicines, taken by the mother, have over the sucking infant, is a circumstance known to every nurse, though Cullen denies it. We can modify the *colour* of the milk by mixing saffron or madder with the food; the *odour* may be affected by various cruciferous and alliaceous plants; the *taste* may be altered by the use of bitters, as wormwood; and lastly, the *medicinal effect* may be also influenced. Children may be salivated by sucking nurses under the influence of mercury, or purged by the exhibition of drastics, or narcotised by the administration of opiates to the nurse. These facts are so familiar to every one, that further evidence of them is scarcely requisite. It is curious, however, that Simon[u] failed to recognise in the milk various salts, which were taken by the mouth, and were found in abundance in the urine. Mental emotions also affect the quality of the milk. I have frequently seen the bowels of the child disordered in consequence of some sudden emotion on the part of the mother. It is also not improbable that diseased conditions of the parent may render the milk unhealthy. Labillardière[v] states that the milk of a cow, affected with a kind of tuberculous phthisis (*pommelière*), contained seven times more phosphate of lime than usual. Dupuy[w] also speaks of the large quantity of calcareous matter in the milk of cows, in whose lungs abundant deposits of the same substance were found. Other morbid changes in the milk have been observed by Donné, Robiquet, and Lassaigne. The facts now mentioned, are of the greatest moment, not only in reference to the frequency of disease in cows, and, therefore, to the possible morbific character of their milk, but they are of considerable importance in reference to the milk of the human subject. I think, with this statement before us, it is highly improper to allow a female, with any trace or suspicion of tuberculous disease, to suckle. Not that a few grains, more or less, of phosphate of lime in the milk, can probably do any injury to the child; but the fact once established, that the milk may be thus altered by disease, leads to the suspicion that some other substances not yet recognised by their physical or chemical characters, may be in the milk of diseased nurses, and which may have an injurious influence on the child; and the suspicion does not confine itself to those affected with tuberculous diseases: other hereditary or constitutional affections may also be attended with altered conditions of the milk. This suspicion is strengthened by the common observation, that the milk of nurses will not equally suit different children. A child, quite healthy, and in good condition, will sometimes, without any evident disease, fall off, and get into what is commonly called a bad condition, apparently from a change of the nurse. I am aware that we cannot always refer this to any positively hurtful matter in the milk. The quantity of nutritive matter in the same quantity of milk of two nurses, may be very different: according to Payen [x], milk with too much nutritive matter in it may disagree with the child. Another point worthy of attention is the quantity of milk yielded in a given time. Payen says it varies in different women as much as from one to ten and a half in the same time.

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[t] Quoted by Cullen, *Mat. Med.*

[u] *Journ. de Pharm.* xxv. 354.

[v] *Dict. Mat. Méd.* iv. 23.

[w] Quoted by Andral, *Treat. on Pathol. Anat.*; by Townshend and West, vol. i. p. 675.

a. *Butter.*—Butter is employed rather as a condiment than as a direct alimentary matter. Its properties have been already noticed[y]. When rendered rancid by keeping,—or empyreumatic by heat, it is exceedingly injurious to the dyspeptic.

Cream consists principally of butter, but mixed with a certain portion of caseum or whey.

b. *Cheese.*—The basis of this is caseum or curd coagulated, somewhat altered in its nature, and mixed with more or less butter. Its richness is in proportion to the quantity of butter present. *Stilton cheese* is prepared from milk to which cream is added. *Cheshire*, and the best *Gloucester cheeses*, are made from unskimmed milk. *Suffolk*, and *Parmesan cheeses*, are prepared from skim-milk. Cheese is nutritious, but difficult of digestion. When old and strong, it is taken as a condiment, to promote the secretion of saliva and gastric juice, and thereby to assist digestion. Toasted cheese is bad for dyspeptics.

Cheese, like sausages and bacon, sometimes acquires poisonous properties by keeping[z].

Class 2. Aves.—Birds.

The eggs and flesh of these animals are used for food.

1. Eggs.—Both the white or glaire and the yolk are employed as food. The former owes its nutritive property to albumen,—the latter to both albumen and oil.

Albumen	12·0
Mucus	2·7
Salts	0·3
Water	85·0
White of Egg	100·0[a]

Albumen	17·47
Yellow oil and fat	28·75
Water	53·78
Yolk of Egg	100·00[b]

Eggs are highly nutritive, and, under some circumstances, are readily digested. When beaten up, in tea, or slightly boiled, they are usually easy of digestion, though with some persons they are very apt to disagree. When boiled hard, and especially when fried in butter or oil, they are exceedingly difficult of digestion, and prove highly injurious to the dyspeptic. The following are the mean times of digestion of eggs, as observed by Dr. Beaumont:—

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[x] *Journ. de Chim. Méd.* t. iv. p. 118.

[y] See p. 52.

[z] Christison, *op. supra cit.*

[a] Bostock, quoted by Gmelin.

[b] Prout, *Phil. Trans.* 1822, p. 388.

	Hour.	*Minutes.*
Eggs whipped, raw	1	30
Eggs fresh, raw	2	0
Eggs fresh, roasted	2	15
Eggs fresh, soft boiled	3	0
Eggs fresh, hard boiled	3	30
Eggs fresh, fried	3	30

The oil of the yolk renders this part of the egg scarcely so easy of digestion as the white or glaire.

2. Flesh.—The flesh of the common dunghill fowl is white, contains but little osmazome, and, when young, is exceedingly tender. The quantity of nutritive matter, in chicken flesh, is thus stated by Mr. Brande:—

100 *Parts of Muscle of*	*Water.*	*Albumen or Fibrine.*	*Gelatine.*	*Total of Nutritive Matter.*
Chicken	73	20	7	27

Chicken flesh is easily digested and nutritious. It is the least irritating or stimulating, perhaps, of all animal foods; and is often retained on the stomachs of invalids when other meats would be immediately rejected. Chicken broth is well adapted for irritable stomachs.

The flesh of wild gallinaceous birds, as the pheasant and the partridge, is darker coloured, firmer, richer in osmazome, somewhat less digestible, and more stimulating than that of chicken.

The flesh of water-fowl, as the goose and duck, is mostly firm, penetrated with fat, and often difficult of digestion. It is scarcely adapted for the invalid[b].

The employment of the enlarged liver of the goose, in the preparation of the *pâtés de foies gras*, has been already referred to[c]. These livers were highly esteemed in the time of Pliny[d]. They contain a quantity of phosphoric oil, which renders them difficult of digestion. Dr. Prout[e] suggests, that indolent and dyspeptic individuals, who partake of these diseased productions, "run considerable risk in inoculating and converting their own livers, or other organs, into a similar mass of disease."

Class 3. Reptilia.—Reptiles.

The Green or Edible Turtle (*Chelonia esculenta*, or *C. midas*) is the only reptile used in this country as food. It is highly nutritive, and, probably, when plainly cooked, is easy of digestion; but when taken in the form of the highly-esteemed "turtle soup," is very apt to disagree with dyspeptics.

Class 4. Pisces.—Fishes.

The quantity of fibrine, albumen, and gelatine, found in some kinds of fish have been ascertained by Mr. Brande, who states them to be as follows:—

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[b] For further details respecting the properties of the flesh of birds, I must refer the reader to Cullen's *Treatise of the Materia Medica*, vol. i. p. 376, Edin. 1789; and Plenck's *Bromatologia*. Viennæ, 1783.

[c] See p. 10.

[d] *Nat. Hist.* lib. x. cap. 27, ed. Valp.

[e] *Op. supra cit.* p. 244.

100 *Parts of Muscle of*	*Water.*	*Albumen or Fibrine.*	*Gelatine.*	*Total of Nutritive Matter.*
Cod	79	14	7	21
Haddock	82	13	5	18
Sole	79	15	6	21

Morin[f] analyzed the flesh of the Smelt, and found it to consist of yellow, phosphoric oily matter, osmazome, gelatine, mucus, albumen, fibrine, sal ammoniac, phosphates of potash, lime, iron, and magnesia, chloride of potassium, and carbonate of lime.

Fish are less satisfying to the appetite than either mammals or birds. They are also less nourishing. Those fish (as salmon and eels), which abound in oily matter, are more nutritive than other kinds, but are proportionably less digestible. The thirst and uneasy feeling at the stomach, frequently experienced after the use of the richer kinds of fish, have led to the use of spirit as a condiment for this kind of food. Hence the vulgar proverb, that "*brandy is Latin for fish*[g]." Skin diseases are said to be more prevalent among those who live much on fish[h]. By the continued use of fish, the seminal secretion is said to be promoted, and the sexual feelings raised. This effect is ascribed to the phosphoric oil which these animals contain[i].

The following are the mean times of digestion of several fish, according to Dr. Beaumont's experiments:—

	Hour.	*Minutes.*
Trout (Salmon), fresh, boiled	1	30
——————— fried	1	30
Cod-fish, cured dry, boiled	2	0
Flounder, fresh, fried	3	30
Salmon, salted, boiled	4	0

The white fish, as whiting, haddock, sole, flounder, the cod, and turbot, are the most easily digestible of the fishes in common use, in consequence of containing less oil. They are also less stimulating to the system, and, therefore, are the best adapted for the use of invalids. The whiting and the haddock are the most delicate and tender; the turbot and the cod the least so. It must be remembered, however, that the sauces (melted butter, &c.), usually taken with these fish, are exceedingly obnoxious to the stomach, and, therefore, must be excluded from the table of the invalid. Salmon, eels, herrings, and sprats, abound in oil; and, in consequence, are difficult of digestion, very apt to disturb the stomach, and are exceedingly injurious to the dyspeptic. By drying, salting, and smoking, the digestibility of fish is diminished.

Some species of fish, especially in tropical climates, possess poisonous properties, either at all times, or at certain seasons. Certain individuals are more susceptible of fish-poison than others[k].

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[f] *Journ. de Pharm.* t. viii. p. 61.

[g] See Dr. George Cheyne's *Essay of Health and Long Life,* p. 41.

[h] Troil's *Letters on Iceland,* p. 319. Lond. 1780.

[i] Foster (*Observations made during a Voyage Round the World,* p. 315, Lond. 1778) has endeavoured to prove "that feeding on fish by no means contributes to the increase of numbers in a nation."

Some of the viscera of fish are prepared and used separately as articles of food. Thus, the swimming-bladder constitutes the well-known *sound* and *isinglass,*—substances of a gelatinous nature, and already noticed[l]. The roe or ovary (commonly called the *hard roe,* to distinguish it from the milt or testicle, called the *soft roe*) of most fishes is eaten. It contains a phosphoric oil. The substance, called *caviare,* is the prepared roe of the sturgeon.

The following is the composition of isinglass and caviare[m].

Gelatine	70·0	Yellow odorous fatty oil	4·3
Ozmazome [?]	16·0	Soluble albumen	6·2
Membrane, insoluble in boiling water	2·5	Insoluble albumen	24·8
Free acid and salts	4·0	Chloride of sodium and sulphate of soda	6·7
Water	7·5	Gelatine, with some salts	0·5
		Water	57·5
Isinglass	100·0	Fresh unpressed Caviare	100·0

"The flesh of any fish is always in the highest perfection, or *in season,* as it is called, during the period of the ripening of the milt and the roe. After the fish has deposited the spawn, the flesh becomes soft, and loses a great deal of its peculiar flavour. This is owing to the disappearance of the oil or fat from the flesh, it having been expended in the function of reproduction[n]."

Class 5. Crustacea.—Crustaceous Animals.

To this class belong Lobsters, Crabs, Cray-fish, Prawns, and Shrimps.—"They have a white, firm flesh, which contains much gelatine. In the membrane, which encloses the calcareous shell, is found a resinous substance, which, in the living animals, is of a brownish-green colour, but becomes red by boiling. From this matter proceeds the peculiar odour and taste of the broth of these animals. The flesh is difficult of digestion; the broth is stimulant. In febrile and inflammatory complaints their use is injurious[o]." A cutaneous eruption, and even colic, sometimes follow their ingestion. Several of the crustacea are poisonous.

Class 6. Mollusca.—Mollusks.

The Oyster, the Muscle, the Periwinkle, the Cockle, the Whelk, and the Limpet, belong to this class[p]. The flesh of the Oyster was analyzed by Pasquier[q], who found it consists of water, 87·4; and of osmazome, mucus, albumen, fibrine, and gelatine, together, 12·6. It furnishes a delicious article of food; and is more digestible in the raw state than when cooked (by roasting, scolloping, or stewing); for the heat employed coagulates and hardens the albumen, and corrugates the fibrine, which are then less easily soluble in the gastric juice; and the heated butter, generally used as an accompaniment, adds still more to the indigestibility of the oyster. The following are the mean times of digestion of oysters, according to the experiments of Dr. Beaumont:—

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[k] On the subject of Fish-poison, the reader is referred to Dr. Christison's *Treatise on Poisons.*

[l] See p. 54.

[m] Gmelin, *Handb. d. Chem.* ii. 1468 & 1469.

[n] Fleming's *Philosophy of Zoology,* vol. ii. p. 373.

[o] Tiedemann, *op. supra cit.* p. 136.

[p] The mollusks just mentioned, and the crustaceous animals used as food, constitute the *Shell Fish* of the shops. Of course, strictly speaking, they are not fish at all.

[q] Gmelin, *Handb. d. Chem.* ii. 1478.

	Hours.	*Minutes.*
Oysters, fresh, raw	2	55
Oysters, fresh, roasted	3	15
Oysters, fresh, stewed	3	30
Oyster soup, boiled	3	30

As far as my own personal observation extends, the finest raw oysters of the London market, usually called *natives*, rarely disagree even with dyspeptics; and Dr. Cullen declares oysters to be easy of digestion. Very opposite, however, is the experience of some other writers[r]. Poisonous effects even have been ascribed to oysters[s]. Considering the enormous consumption of these animals, their supposed ill effects must be of extremely rare occurrence. The accuracy of the statement of Dr. Clarke[t], that oysters, taken immediately after delivery, are apt to occasion apoplexies or convulsions, appears to me to be improbable. An aphrodisiac property is usually ascribed to oysters. These mollusks have been recommended in phthisis, and in some abdominal affections. The Muscle has on many occasions operated as a poison[u]. The Great or Vineyard Snail (*Helix pomatia*) is a popular remedy for emaciation, with hectic fever and phthisis, on account of its supposed nourishing qualities.

β. *Vegetable Aliments.*

These may be arranged in eight classes:—

1. Seeds.
2. Fleshy Fruits.
3. Roots, Subterranean Stems, and Tubers.
4. Buds and Young Shoots.
5. Leaves and Leafstalks
6. Receptacles and Bracts.
7. Stems.
8. Cryptogamia, or Flowerless Plants.

CLASS 1. Semina.—Seeds.

The seeds used as food are of two kinds, farinaceous and oleaginous.

1. MEALY OR FARINACEOUS SEEDS.—The most important of these are the Cereal Grains and the Leguminous Seeds. The Chestnut also belongs to this kind of seeds.

The nutritive principles of the *Cereal grains* are Starch, Gluten,

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[r] Pearson. *Pract. Synopsis of the Materia Alimentaria*, Lond. 1808; Paris's *Treatise on Diet*, 5th ed. Lond. 1837.
[s] See Christison's *Treatise on Poisons.*
[t] *Trans. of the London College of Physicians*, vol. v. p. 109.
[u] Christison, *op. supra cit.*

Gum, and Sugar. Of these grains none equal *Wheat* in nutritive qualities, which it owes to the large quantity of gluten which it contains. It yields the finest, whitest, and most digestible kind of bread. *Oats* are nutritive, but less so than wheat. Oatmeal "is especially the food of the people of Scotland, and was formerly that of the northern parts of England; counties which have always produced as healthy and as vigorous a race of men as any other in Europe[v]." Unfermented oat-bread, in those unaccustomed to it, is apt to occasion dyspepsia, with heartburn, and was formerly thought to have a tendency to cause skin diseases, but without just grounds. Gruel is a mild, nutritious, and easily-digested article of food, in fevers and inflammatory affections. It is well adapted for irritable conditions of the stomach. *Barley*, when deprived of the husk (which is slightly acrid and laxative), is highly nutritious. Count Rumford[w] regards barley-meal, when used for soup, as three or four times as nutritious as wheat-flour. Barley-bread is said to be more difficult of digestion than wheaten bread. Barley-water is a mild, easily digestible liquid. *Rye* is nutritive, but less so than wheat. In those unaccustomed to it, rye-bread is apt to occasion diarrhœa, which Cullen ascribes to its readily becoming acescent. *Rice* is the ordinary sustenance of many oriental nations. Being less laxative than the other cereal grains, it is frequently prescribed, by medical men, as a light, digestible, uninjurious article of food, in diarrhœa and dysentery; and, in consequence, it is, with the public, a reputed drying and astringent agent. Various ill effects, such as disordered vision, &c. have been ascribed to its use[x]; but without any just grounds. Neither does there appear to be any real foundation for the assertion of Dr. Tytler[y], that malignant cholera (which he calls *morbus oryzeus!*) is induced by it. *Maize*, or *Indian Corn*, is nutritive; but, being deficient in gluten, is not adapted for manufacture into bread. It is apt to occasion diarrhœa in those unaccustomed to it[z]. In America, Asia, and some parts of Europe, it is used largely for human sustenance[a]. *Millet*, both common and Italian, is cultivated in Italy as an article of food. *Sorghum*, *Durra*, or *Guinea Corn*, is another of the cerealia employed, in some parts of Africa, as an article of food.

Various foods are prepared from the meal or flour of the cerealia. The most important of these is Bread.

1. BREAD.—There are two principal kinds of bread,—the one fermented or leavened, the other unfermented or unleavened.

a. Fermented or leavened bread.—The best is that made from wheat, as I have before stated. *Fine bread*, prepared from flour only, is the most nutritive and digestible. That which contains the bran is laxative, and is used by persons troubled with habitual constipation. *Rolls*, and other kinds of *fancy bread*, are less digestible than the common loaf bread. All kinds, when eaten new, are injurious to dyspeptics.

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[v] Cullen's *Materia Medica*, vol. i. p. 278.

[w] *Essay on Feeding the Poor.*

[x] Bontius, *Account of the Diseases, Natural History, &c. of the East Indies.* Translated into English, p. 129. 1769.—Bricheteau, in Tortuelle's *Elém. d'Hygiène*, 4me éd.

[y] *Lancet*, 1833–4, vol. i.

[z] Dunglison, *Elements of Hygiene*, p. 289. Philadelphia, 1835.

[a] For further particulars respecting Maize, consult Cobbett's *Treatise on Cobbett's Corn; Quart. Journ. Agricult.* i.; and *Mém. de l'Acad. Roy. de Méd.* t. ii. p. 206, Paris, 1833.

b. Unfermented or unleavened bread.—Biscuit is the best kind of unleavened bread, and sometimes suits the stomach of the dyspeptic when leavened bread disagrees. That which is free from butter is to be preferred.

2. PASTRY. (*Baked paste*).—The action of heat on the butter or lard used in the manufacture of pastry, renders this compound highly injurious to the dyspeptic. "All pastry is an abomination:" justly observes Dr. Paris. "I verily believe," he adds, "that one half, at least, of the cases of indigestion which occur, after dinner-parties, may be traced to this cause."

3. PUDDINGS, PANCAKES, &c.—"The most digestible pudding is that made with bread, or biscuit and boiled flour: *batter* pudding is not so easily digested; and *suet* pudding is to be considered as the most mischievous to invalids in the whole catalogue. *Pancake* is objectionable, on account of the process of frying imparting a greasiness, to which the dyspeptic stomach is not often reconciled[b].

Of the *Leguminous Seeds*, peas and beans are the best known. Their composition, as determined by Einhof, is as follows:—

	Peas (Pisum sativum).	*Garden Bean (Vicia Faba).*	*Kidney Bean (Phaseolus vulgaris).*
Starch	32·45	34·17	35·94
Amylaceous fibre	21·88	15·89	11·07
Legumin	14·56	10·86	20·81
Gum	6·37	4·61	19·37
Albumen	1·72	0·81	1·35
Extractive matter	2·11	3·54	3·41
Membrane	—	10·05	7·50
Water	14·06	15·63	(dried)
Salts	6·56	3·46	0·55
Loss	0·29	0·98	—
	100·00	100·00	100·00

Peas and beans are nutritious; but they are apt to disturb the digestive organs, and to occasion flatulence and colic. Their difficult digestibility increases with their age. When young, they are less nourishing, but more digestible. They are usually regarded as being somewhat stimulating or heating, and, therefore, not adapted for febrile and inflammatory affections. Their stimulant influence on horses is well know to veterinarians.

The *Chestnut* possesses considerable nutritive power, and in Lombardy is used as food by the lower classes. Its sweetness, especially when roasted, indicates the presence of sugar. No oil can be obtained from it by pressure. In the raw state, it is very difficult of digestion: it requires to be cooked (roasted) to split the starch grains which it contains, and thereby to render them readily digestible. Dyspeptics should carefully avoid chestnuts, even in the cooked state.

2. OILY SEEDS.—To this division belong the Almond[c], the Walnut, the Hazel-nut, the Cashew-nut, the Pistachio-nut, the Stone-Pine-nut (Pignoli-Pine), and the Cocoa-nut. These contain a quantity of

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[b] Paris's *Treatise on Diet*, p. 233, 5th ed. 1837.

[c] The properties of this seed, which may be taken as the type of the oily seeds, will be fully described in a subsequent part of this work.

fixed oil, which, while it confers on them great nutritive qualities, renders them very difficult of digestion. Their use should be carefully avoided by all dyspeptics.

CLASS 2. Fleshy Fruits.

A considerable number of the esculent fleshy fruits will be described in a subsequent part of this work: hence a brief notice of them will be sufficient here.

1. STONE FRUITS. *Drupes.*—The Peach, the Apricot, the Nectarine, the Plum, and the Cherry, are the principal stone-fruits used in this country. They are usually regarded as difficult of digestion; and the popular opinion is probably the correct one, for Dr. Beaumont found that from six to ten hours were required for the artificial digestion of peaches. They are apt to disorder the digestive organs, and to occasion griping and relaxation.

2. POMACEOUS FRUITS. *Apples.*—The Apple, the Pear, and the Quince, are difficult of digestion; the Pear being the least so.

3. BACCATE FRUITS. *Berries.*—The Grape, the Gooseberry, and the Currant, are berries. Their skins (epicarps) and seeds are indigestible. The pulp is apt to relax the bowels. The Grape, if taken without the skin and seeds, is the safest of these fruits.

4. AURANTIACEOUS FRUITS. *Hesperidium* or *Aurantium.*—The Orange, the Lemon, the Citron, the Lime, and the Shaddock, belong to this group. The Orange, when unripe, is apt to cause griping; but when quite ripe, is rarely inadmissible: the seeds and white tissue of the rind should, however, be rejected.

5. CUCURBITACEOUS FRUITS. *Pepones.*—To this head belong the Melon, the Pumpkin, the Vegetable Marrow, and the Cucumber. They yield but little nutritive matter, and readily disagree with the dyspeptic.

6. LEGUMINOUS FRUITS. *Legumes.*—The Tamarind contains but little nutriment. The legume of the Phaseolus vulgaris, or kidney-bean, is brought to the table when boiled.

7. SYCONUS.—Figs are nutritive, but are apt to occasion flatulence, griping, and relaxation of bowels, especially in children.

8. SOROSIS.—The Mulberry yields but little nutritive matter, and readily disorders the bowels. The Pine-apple belongs to this division of fruits.

9. ETÆRIO.—The fleshy receptacle of the Strawberry is not, for the most part, injurious; especially when the achenia (commonly termed seeds) are removed.

CLASS 3. Roots, Subterranean Stems, and Tubers.

The most important of these is the Potato; which, when in good condition and boiled, furnishes a highly nutritious and easily digested article of food. Potatoes are more palatable and nutritive when boiled so as to make them moderately soft, though not to injure their shape; but they are more digestible when boiled so as to be easily mashed. Waxy and new potatoes are less digestible than old mealy ones. Potatoes, which have germinated, have sometimes proved noxious to cattle, and which is said to arise from the large quantity of *solanina* contained in the buds. The process of cooking potatoes is probably useful in two ways: it splits the starch grains, and thereby renders them readily digestible; and secondly, it destroys or extracts some noxious matter. The latter circumstance seems proved by the fact, that the water in which potatoes have been boiled, has, on some occasions, been found to possess poisonous properties.

Of the *Cruciferous* or *Siliquose* roots used as food, the Turnip contains the most nourishment, and is readily digested, though occasionally it creates flatulence.

The *Umbelliferous* roots, in common use, are the Carrot and the Parsnip. These are saccharine, and slightly nutritive; but the volatile oil, which they contain, renders their flavour unpleasant to many persons, and causes them to be apt to disagree with dyspeptics.

CLASS 4. Buds and Young Shoots.

Onions, Leeks, Garlic, and the Shallot, are usually ranked among roots. They are, however, subterranean buds, with thick and fleshy scales. When deprived, by boiling, of their acrid volatile oil, they are slightly nutritive.

The young shoots of Asparagus are nourishing. When eaten, they communicate a peculiar odour to the urine. The melted butter eaten with them is injurious to the dyspeptic.

CLASS 5. Leaves and Leaf Stalks.

The herbaceous part of the Water-Cress, the leaves of Lettuce and of Endive, and the seed-leaves of White Mustard and Common Cress, are eaten raw under the name of salads (*Acetaria*), with the addition of vinegar, oil, salt, and pepper. They yield very little nourishment.

The Cabbage, the Cauliflower, Broccoli, the Savoy, Spinach, &c. are employed only when boiled. They are apt to disagree with dyspeptics. Spinach usually relaxes the bowels.

The stalks of Rhubarb leaves are used for tarts and puddings. Their use is objectionable when there is a tendency to oxalate of lime calculi. "I have seen," observes Dr. Prout[d], "well-marked instances in which an oxalate of lime nephritic attack has followed the free use of rhubarb (in the shape of tarts, &c.), particularly when the patient has been in the habit, at the same time, of drinking *hard water.*"

CLASS 6. Receptacles and Bracts.

The fleshy receptacle and bracts of the Artichoke are used as food.

CLASS 7. Stems.

From the stems of several Cycadaceæ, as well as of some Palms, is obtained a farinaceous substance, which is employed, in the countries where it is procured, as an article of food. Sago is procured from this source.

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[d] *Op. supra cit.* p. 65.

Class 8. Cryptogamia.—Flowerless Plants.

No important articles of food are obtained from this class.

1. Ferns.—From the rhizomes of ferns is obtained, in some of the Polynesian Islands, as well as in some other parts of the world, a farinaceous or ligneous matter, which is employed by the natives as a nutritive substance[e].

2. Lichens.—Several species of *Gyrophora* (as *G. proboscidea* and *cylindrica*) are employed by the hunters of the Arctic regions of America as articles of food, under the name of *tripe de roche.* They supported Capt. Sir John Franklin and his companions, in 1821, for many days. The bitter principle of these plants, however, proved noxious to several of the party[f]. Iceland moss also yields nutritive matter; but, to be available as food, the bitter matter of the lichen must be separated.

3. Algæ. *Sea Weeds.*—Several species of the inarticulated Algæ are occasionally employed, in some parts of the British islands, as articles of food, or as condimentary substances[g]. *Laver* is sometimes met with in the London shops.

4. Fungi. *Mushrooms.*—Though a considerable number of species of fungi are edible—in fact, several form delicious articles of food—a small number only is in common use in this country. This has arisen, in great measure, from the difficulty experienced by the public in discriminating wholesome from poisonous species. Nay, it would appear that the same species is under some circumstances edible, under others deleterious. This, if true, is a very proper ground for distrust. "So strongly did the late Professor L. C. Richard feel the prudence of this, that although no one was better acquainted with the distinctions of fungi, he would never eat any; except such as had been raised in gardens in mushroom beds[h]." The edible species in most common use in this country are, 1st. *Agaricus campestris* (*common field* or *cultivated mushroom*), which, in the adult state, is employed in the preparation of ketchup, and is eaten fresh, either stewed or broiled: the young or button mushroom is pickled. 2dly. *Morchella esculenta* (*common morel*), employed to flavour gravies, ragouts, &c. 3dly. *Tuber cibarium* (*common truffle*), a subterraneous fungus, used for seasoning. No less than thirty-three species of fungi are eaten in Russia[i].

b. *Potulenta.—Drinks.*

The liquids, taken by the mouth to quench thirst, are denominated drinks. Of these, a very brief notice is all that can be given here. Several of them will be more fully noticed in subsequent parts of this work.

1. Aqua. *Water.*—This is probably the natural drink of all adults. It is a vital stimulus, and is more essential to our existence than ali-

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[e] Tiedemann, *op. supra cit.* p. 203.

[f] *Narrative of a Journey to the Shores of the Polar Sea.* Lond. 1823.

[g] See Greville's *Algæ Britannicæ.* Edin. 1830.

[h] Lindley, *Nat. Syst. of Bot.* 2d edit. p. 442.

[i] Dr. Lefrere, *Lond. Med. Gaz.* xxiii. p. 414.

ment. It serves at least three important purposes in the animal economy: firstly, it repairs the loss of the aqueous part of the blood, caused by the action of the secreting and exhaling organs; secondly, it is a solvent of various alimentary substances, and, therefore, assists the stomach in the act of digestion, though, if taken in very large quantities, it may have an opposite effect, by diluting the gastric juice; thirdly, it is probably a nutritive agent,—that is, it assists in the formation of the solid parts of the body. From the latter opinion, which I hold with Count Rumford[j], many, however, will be disposed to dissent.

Soft water is to be preferred as a drink to hard water, because it is a better solvent of vegetable and animal matters; and furthermore, because the continued ingestion of the saline constituents of hard waters may slowly prove injurious in some diseases. *The presence of decomposing organic matter* renders water highly noxious. Dr. Lambe[k] considered it to be the cause of various constitutional diseases, and hence he advocated the use of distilled water; but of the accuracy of his opinion we have not sufficient evidence. The obvious effect which results from the use of water containing putrescent matter, is dysentery[l]. It is a curious, but well established fact, that *pure* water more readily acquires a metallic impregnation from leaden cisterns or pipes, than *hard* water. Distilled water, aided by atmospheric air, readily corrodes lead: but if a neutral salt, as chloride of sodium or sulphate of soda, be added to the water, the corrosive action is impaired. Hence rain-water is more apt than well-water to become impregnated with lead.

2. Toast-Water.—Water is rendered much more palatable and agreeable when impregnated with toasted bread or biscuit. The toast communicates to it a little gum, and an empyreumatic matter. From the latter the water acquires colour and flavour.

3. Tea.—Notwithstanding the extensive employment of tea in this country, it is no easy matter to ascertain its precise effects on the system. Its astringency is fully proved by its chemical properties. Its peculiar influence over the nervous system, and which is especially manifested after the use of green tea, is another well-established effect. This influence is, in some respects, somewhat allied to that exercised by fox-glove: for both tea and foxglove diminish the tendency to sleep, and act as sedatives to the vascular system. Hence tea is employed as a drink by those who are accustomed to nocturnal study. Strong green tea, taken in large quantities, is capable, in some constitutions, of producing most distressing feelings[m]; and of operating as a narcotic. Part of the effects sometimes ascribed to it are referrible to the water, the temperature at which it is swallowed,

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[j] *Essays*, vol. i. p. 194, 5th ed. 1800.

[k] *A Medical and Experimental Inquiry into the Origin, Symptoms, and Cure of Constitutional Diseases*. Lond. 1805.

Dr. Cheyne, in the *Dublin Hospital Reports*, vol. iii. p. 11.—Dr. Copland's *Dict. of Pract. Med.* art. *Dysentery*, p. 698-99.—At the Nottingham Assizes, in 1836, it was proved at a trial, on which I was a witness, that dysentery, in an aggravated form, was caused in cattle by the use of water contaminated with putrescent vegetable matter, produced by the refuse of a starch manufactory (See a brief report of the trial in the *Veterinarian* for 1836, p. 457).

[m] Dr. E Percival, *Dubl. Hosp. Reports*, vol. i. p. 219.

or to the substances (milk and sugar) added to it. Weak tea rarely disagrees with the invalid, and is admissible and refreshing in a variety of maladies. It is well adapted for febrile and inflammatory complaints; and is particularly valuable when we are desirous of diminishing a tendency to sleep.

4. COFFEE is a tonic and stimulating drink. It occasions thirst, and not unfrequently disorders the bowels. It is usually described as having constipating effects; but I know two individuals on whom it has a relaxing effect. It possesses anti-soporific powers, and is used, therefore, by those who desire nocturnal study.

5. CHICORY, or SUCCORY, yields a wholesome beverage, but which wants the fine aromatic flavour for which coffee is so celebrated. I am informed, however, that the flavour of coffee mixed with chicory is preferred by some persons to that of unmixed coffee.

6. CHOCOLATE is a very nourishing beverage, devoid of some of the ill qualities ascribed to tea and coffee; but, on account of the oil which enters into its composition, it is difficult of digestion, and is apt to disagree with dyspeptics.

7. COCOA is less oily, and being somewhat astringent, is adapted for persons with relaxed bowels.

8. BEER. *Malt Liquor.*—Under this head are included Ale, Stout, Porter, and the weaker kinds of beer, commonly known as Table or Small Beer. All these are fermented decoctions of malt and hops. Their specific gravity is as follows:—

	Sp. gr.		*Sp. gr.*
Ale, Burton, 1st sort..	1·111 to 1·120	Porter, common sort..	1·050
„ „ 2d sort..	1·097 to 1·111	„ double	1·055
„ „ 3d sort..	1·077 to 1·092	Brown Stout	1·064
„ Common	1·070 to 1·073	„ „ ditto best	1·072
„ Ditto	1·058	Beer, common small..	1·014
		„ good table	1·033 to 1·039

Beer consists of *water*, *alcohol*, *lupulite* (the bitter principle of hops), *volatile oil of hops*, *gum*, *sugar*, *gluten*, *brown extractive*, *a small portion of tannic acid*, *carbonic acid*, and *the phosphates of lime and magnesia* held in solution by *phosphoric* and *acetic acids*. The quantity of alcohol in beer is as follows:—

	Proportion of spirit (sp. gr. 0·825) per cent. by Measure.	*Ditto, per cent. by Weight.*
Ale, Burton	8·88	7·326
„ average	6·87	5·667
Brown Stout	6·80	5·610
London Porter (average)	4·20	3·465
„ Small Beer	1·28	1·056

By distillation the alcohol may be readily separated. On evaporation, beer furnishes a brown extractiform residue.

Beer differs from wine in several important particulars. Thus it contains a much larger quantity of nutritive matter, and a considerably less proportion of alcohol; but it has, in addition, a peculiar bitter and narcotic substance. That its inebriating quality does not wholly depend on the alcohol which it contains, is shewn by comparing the quantity of spirit obtained by Mr. Brande from brandy, wine, and porter. From his experiments, it appears that the same quantity of spirit is contained in the following quantities of wine, brandy, and beer:—

Port Wine	1·00
Claret	1·52
Champagne	1·82
Brandy	0·43
Burton Ale	2·58
London Porter	5·46
Small Beer	18·16

Now if the intoxicating quality of beer depended on the spirit merely, the effect of five and a half pints of London porter, or two and a half pints of Burton ale, should be equal only to that of a pint of port wine; whereas its actual inebriating power greatly exceeds this.

That beer is nutritive, and, when used in moderation, salubrious, can scarcely be doubted. It proves a refreshing drink, and an agreeable and valuable stimulus and support, to those who have to undergo much bodily fatigue. The poor labourer who has repeatedly experienced its invigorating property, will by no means admit the truth of Dr. Franklin's assertion[n], that a penny loaf and a pint of water yield more nourishment than a pint of beer. The hop operates as a tonic, and assists digestion. With dyspeptics, beer, as well as other fermented liquors, are very apt to disagree. By them, therefore, its use should be carefully avoided. Furthermore, it is objectionable for those liable to lithic acid deposits, and for plethoric persons who have a tendency to apoplexy.

The difference between *ale* and *porter* deserves a slight notice. The first is pale-coloured and sweetish; being prepared from pale or amber-coloured malt, which contains a large quantity of saccharine matter. Porter, on the other hand, is deep-coloured and devoid of any sweet taste. It is prepared from high dried or rather charred malt, which has had its saccharine matter destroyed by heat. Hence ale is more objectionable for diabetic and dyspeptic patients than porter. From this statement we ought perhaps to except the ales prepared for the India market, which are free from saccharine matter, and contain double the usual proportion of hops[o].

9. WINES.—It cannot be denied, that the most perfect health is compatible with total abstinence from wine; and that from the use of this liquid various diseases have been produced, kept up, or aggravated. I am by no means, however, disposed to deny the accuracy of the statement of Dr. Paris[p], that "there exists no evidence to prove that a temperate use of good wine, when taken at seasonable hours, has ever proved injurious to healthy adults;" since he has so qualified this sentence, that in any cases where ill effects appear to result from the use of wine by adults, they may safely be ascribed to

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[n] *Select Works*, by W. T. Franklin, vol. i. p. 36. Lond. 1818.
[o] See Prout, *op. supra cit.* p. 44.
[p] *Treatise on Diet*, p. 268, 5th ed.

the nonfulfilment of some of the conditions here mentioned,—(viz. the *temperate* use of wine,—the *goodness* of the liquor,—the *seasonable* time of taking it,—or the *health* of the individual).

It must be admitted, that the most perfect health is compatible with the moderate enjoyment of wine, and that many individuals who attain a good old age, have, during a considerable period of their life, been in the habit of using wine daily. Moreover, persons who have been accustomed to the temperate use of wine, are likely to suffer if deprived of their accustomed stimulus. In a subsequent part of this work, some remarks will be offered on the different qualities of different wines, and their medicinal uses. I shall merely remark here, that in forming an opinion as to the kind of wine best adapted for the dietetical use of our patients, we should consider its colour, its alcoholic strength and intoxicating property, its sweetness, the nature and quantity of acid which it contains, and its age. The *red* wines contain more extractive and colouring matters (derived from the husk of the grape), which are apt to disagree with some dyspeptics. With regard to its *alcoholic strength* and *intoxicating quality*, it deserves to be especially remembered that the inebriating property of wine is not proportional to the quantity of contained alcohol,—since champagne is more intoxicating, though less alcoholic, than port wine[q]. Its *sweetness* requires especial consideration in dyspeptic and urinary diseases; in some of which (as in diabetes), the employment of saccharine matter is highly objectionable. Without adopting the prejudices of Sir A. Carlisle[r], against the use of *acids*, it cannot be doubted that the employment of acid wines (as claret and hock) is calculated to prove, on many occasions, injurious; and in such cases sherry is used in preference to other wines. In phosphatic urinary deposits, however, they prove serviceable. By keeping, wine deposits bitartrate of potash, and colouring and extractive matters, which are very apt to disagree with some patients. Hence *old* wines are to be preferred to *new* ones.

10. Ardent Spirits.—Brandy, Rum, Gin, and Whiskey, are the ardent spirts most frequently used in this country. Various compounded spirits (those imported are termed *Liqueurs*) are also employed as cordials. The injurious effects of spirit will be pointed out in a subsequent part of this work. I shall here confine my attention to its dietetical use. Brandy is frequently used at the table, as a gastric stimulant, to promote the digestion of substances difficult of solution in the juices of the stomach, as the oily fish. That various uneasy sensations, referred to the scrobiculus cordis, are often relieved by it, cannot be denied; but of the existence of any other benefit we may fairly doubt; while the ill consequences of frequently resorting to spirit are undoubted. Dr. Paris states that in some cases of dyspepsia, wine and beer equally disagree with the stomach, producing acidity and other distressing symptoms; and in

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[q] See p. 71.

[r] *Essay on the Disorders of Old Age.*

such, he observes, "very weak spirit may, perhaps, be taken with advantage." In confirmation of the accuracy of the observation I can bear testimony; having repeatedly found the substitution of a very weak spirit preferrible to fermented liquors.

11. CARBONIC ACID WATERS.—To this head belong Soda Water, Ginger Beer, and Effervescing Lemonade. These are refreshing, grateful beverages; though by distending the stomach with gaseous air, they must prove injurious to the process of digestion.

12. ACIDULATED WATERS.—Lemonade and Imperial are pleasant, refreshing drinks, which, however, are apt to disagree with dyspeptics.

13. SACCHARINE AND MUCILAGINOUS DRINKS.—Sugar-water and Gum-water are also liable to disturb the stomach of the dyspeptic.

14. INFUSIONS OR DECOCTIONS OF ANIMAL SUBSTANCES.—Under this head are included Beef Tea, Mutton, Veal, and Chicken Broths, and Soups. *Beef Tea* is a light, pleasant, and slightly nutritive article of diet, adapted for invalids. Spices are sometimes advantageously added to it. *Mutton Broth* is apt to disagree with persons having delicate stomachs, especially if the fat be not skimmed from it. It is frequently given to promote the operation of purgative medicine. *Chicken Broth* is the least disposed to disturb the stomach of all the animal decoctions. It is especially adapted for invalids with great irritability of stomach. *Veal Broth* is less frequently used. *Soups* are not adapted for invalids. Their basis is gelatine, whose nutritive qualities have been already described[s].

15. GRUEL AND BARLEY WATER.—*Gruel* is prepared from groats or oatmeal. It is a bland, nutritious, easily digestible, emollient liquid, well adapted for the use of invalids, and rarely disturbing the stomach. Sugar, lemon juice, aromatics, or butter, are frequently added, but they (especially butter) are by no means generally admissible. *Barley water* is a thinner, less viscid liquid. It is used as a mild, demulcent, slightly nutritive drink, for invalids, in febrile and inflammatory disorders.

16. MILK.—Milk is the natural drink of man during the first period of his infancy. Its nutritive qualities have been already noticed[t]. On account of the butter which it contains, it is apt to disagree with some adults: in common language, it sometimes lies heavy at the stomach. *Cream* is still more injurious. *Whey* is an agreeable beverage.

c. CONDIMENTA.—CONDIMENTS.

These are substances which are taken with the food to improve its flavour, to promote its digestion, or to correct any injurious quality which it may possess. Some of them are also nutritive.

1. SALINE CONDIMENTS.—Common salt, or the chloride of sodium, is the only saline condiment essential to health. It is taken by man, as well as by many animals, on account of its agreeable flavour; but the existence of a greater or less appetite for it, in all individuals, appears to me to shew that this substance must serve some

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[s] See p. 55.

[t] See p. 57.

more important uses in the animal economy than that of merely gratifying the palate. In considering these, we observe, in the first place, that it is an essential constituent of the blood, which fluid probably owes some of its essential properties to its saline matter. Now as the blood is constantly losing part of its saline particles by the secretions (the tears, bile, &c.), the daily loss is repaired by the employment of chloride of sodium as a condiment. In the second place, the free hydrochloric acid found in the stomach, and which forms an essential constituent of the gastric juice, is obviously derived from the salt taken with our food. Thirdly, the soda of the blood, and of some of the secretions, is doubtless obtained from the decomposition, in the system, of common salt. These are some (probably only a portion) of the uses which chloride of sodium serves in the animal economy. It deserves especial notice, that while salt is thus essential to health, the continued use of salted provisions is injurious. But their noxious quality is probably to be referred rather to the meat, whose physical and chemical qualities are altered, than to the presence of the salt; though we can readily conceive that an excessive use of salt, or of any other article of food, will be followed by injurious consequences. However relishing salted fish (as anchovies, herrings, cod, &c.) may be, they are difficult of digestion.

2. Acidulous Condiments.—Vinegar is a grateful condiment, and is used either alone, or with pickles. When taken in small quantities, it is quite wholesome. It allays thirst, and operates as a refrigerant. It probably promotes digestion, not merely by the stimulus which it communicates to the stomach, but by its power of dissolving several alimentary principles,—as fibrine, albumen, and gelatine. The frequent use of it is supposed to diminish obesity. It checks the secretion of milk, and at the same time injures the quality of this liquid. Lemon-juice, or a solution of citric acid, is an acidulous condiment.

3. Aromatic and Pungent Condiments.—This division includes the spices (as Pepper, Nutmegs, &c.), the savoury herbs of the family Labiatæ (as Thyme, Sage, &c.), some Umbelliferous fruits (as Caraway), several products of the family Cruciferæ (as Mustard, Horseradish, &c.), and the alliaceous substances (as Onions, Garlic, &c.) They are employed as condiments, partly for their flavour, and partly to promote the digestion of some kinds of food which experience has shown, are not by themselves easily or readily digested. Moreover, the cruciferous and alliaceous condiments are esteemed antiscorbutics.

By the inhabitants of the torrid zone they are extensively used to counteract the debilitating influence of heat, as already mentioned[u]. In temperate climates their employment is not so important; on the contrary, their copious use is injurious.

4. Oily Condiments.—Butter and oil are used at the table as condiments. Their general effects, as nutritive substances, have

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[u] See p. 10.

been already noticed[v]. They become more difficult of digestion and more noxious to the dyspeptic, in proportion to the heat to which they are subjected in the process of cooking.

5. Saccharine Condiments. — Sugar, honey, and treacle, are employed as condiments. The nutritive properties of saccharine substances have been before noticed[w]. When taken in small quantities, and largely diluted, as in tea, coffee, &c. sugar is said to be very apt to disagree, and give rise to flatulency and gastric uneasiness. Used in the form of preserves, it is also apt to disorder the stomach of dyspeptics.

Under the name of *Sauces*, are used at the table mixtures of various condiments. Ketchup (made from either Mushrooms or Walnuts), Soy, and Essence of Anchovies, are those which are most frequently employed. Salt and spices are essential ingredients of them. Vinegar is also a constituent of some.

Dietetical Regimen.

In the treatment of many diseases, attention to diet is a point of considerable importance. In none is it more necessary than in non-febrile disorders of the digestive and urinary organs. In acute maladies, in which abstinence or low diet is requisite, there is usually no disposition to take food: on the contrary, solids of all kinds are generally loathed. In such cases, therefore, there is less chance of any error of diet being committed. Dietetical regimen is more important in chronic diseases of the assimilating organs, in which the appetite is unimpaired, or even increased,—since in such the patient is more apt to overstep the bounds of prudence, by the employment of a diet, improper either from the quantity or quality of the food used. In chronic local diseases, when the constitution is unimpaired and the appetite for food remains natural, I would by no means advocate the adoption of a spare or low diet; since I believe that in such cases the indulgence of a moderate appetite for plain food, is attended with beneficial results. From this statement, however, maladies affecting the organs of assimilation must be excepted.

Several diets or kinds of dietetical regimen are employed in the treatment of diseases. The most important of these are the following:—

1. Animal Diet.—This term is applied to a diet composed of animal food, either exclusively or principally. The only disease, in which a diet exclusively of animal food is recommended, is diabetes. In this malady, strict abstinence from vegetable substances is attended with the diminution or cessation of the saccharine condition of the urine, and a reduction in the quantity of this fluid passed. It deserves especial notice that the quantity, as well as the quality, of the food taken in this disease, requires to be carefully attended to, as the craving for food is apt to induce the patient to indulge to an

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[v] See p. 51.

[w] See p. 48.

injurious extent. As an example of a dietary of animal food for a diabetic patient, I select the following, adopted by Dr. Christison[x], for a patient in the Edinburgh Infirmary:—

	Ounces.	Ounces of dry nutritive principles contained therein[y].
Fresh Meat	40	10·8
Cheese	2	2·0
Two Eggs	—	1·0
New Milk	48	8·0
Beef Tea	16	0·25
Total		22·05

In a second case only 20 oz. of meat were allowed.

In private practice, it will be convenient to allow other kinds of animal food in addition to the foregoing: as butter, chicken, sausages, fish, shell-fish, brawn, and poultry. For common drink, water, or beef-tea, or mutton-broth, may be sparingly allowed[z].

The beneficial effects of a diet of animal substances exclusively in diabetes is, in most cases, temporary only; while its rigorous adoption is apt to be attended with febrile or inflammatory affections[a]. Moreover, a difficulty in its employment is often found in the inordinate craving for vegetable substances, and the loathing of animal food, experienced by the patient. Hence most practitioners have permitted the use of a limited quantity of farinaceous food, in the form of biscuit or bread. Rice may be occasionally admitted. Arrow-root, potatoes, and other low kinds of farinaceous substances, are less proper. Dr. Prout recommends sound porter in preference to wine or spirits.

In several other maladies the use of animal substances chiefly has been advised; as in the oxalate of lime diathesis, and in scrofula. Furthermore, it is admissible in other cases, where we are desirous of employing a highly nutritious and stimulating diet.

2. Vegetable Diet.—The exclusive employment of vegetable foods has been very rarely adopted. It has been eloquently advocated by Dr. Lambe[b], who recommends it, in conjunction with the use of distilled water, as a remedy for cancer, scrofula, consumption, asthma, and other chronic diseases; but he has, I suspect, gained few, if any, proselytes to his opinions and practice.

The term *spare* or *abstemious diet* is sometimes used to indicate the employment of vegetable substances principally (not exclusively). It generally includes the use of the white fish, sometimes alternating with a limited quantity of poultry or butchers' meat. In plethoric habits, where the appetite is unimpaired, this diet is ordered in cases of threatened apoplexy, gout, &c. By its adoption we diminish the quantity of nutritive matter supplied to the system, while we keep the digestive organs actively employed.

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[x] *Edinb. Monthly Journal*, April 1841, p. 236.

[y] The quantities stated in this column appear to me too high. They are taken from Dr. Christison's statement at p. 240, *op. supra cit.*

[z] For some further remarks on the use of animal diet in diabetes, see p. 48 and 53.

[a] Dr. Marsh, in the *Dublin Hospital Reports*, vol. iii. p. 453, 1822.

[b] *Reports of the Effects of a Peculiar Regimen on Scirrhous Tumours and Cancerous Ulcers.* Lond. 1809.—*Additional Reports on the Effects of a Peculiar Regimen in cases of Cancer, Scrofula, Consumption, Asthma, and other Chronic Diseases.* Lond. 1815.

3. Milk Diet.—Besides cow's milk, which constitutes the principal article of food, this diet includes the use of farinaceous substances (such as arrow-root, sago, and tapioca), bread, and light puddings (of rice, bread, or batter). Milk diet is ordered when we are desirous of affording support to the system with the least possible stimulus or excitement. It is well adapted for inflammatory diseases of the chest (phthisis especially), of the alimentary canal, and of the bladder, when it is considered expedient to employ a nutritious but not stimulating diet. After hemorrhages, when the powers of the system have been greatly exhausted, a milk diet is frequently beneficial. It has also been considered one of the best means of preventing and of curing the gout. It is a good diet also for many of the diseases of children, especially those of a strumous or scrofulous nature. In some of the above-mentioned maladies, where the stomach is weak and irritable, cow's milk is apt to occasion vomiting and other unpleasant effects, in consequence of the butter which it contains. In such cases, skim-milk or ass's milk may be advantageously substituted.

4. Low Diet.—In acute inflammation, in fever, and after serious accidents, surgical operations, and parturition, patients are directed to adopt a low diet, consisting principally of the use of *slops* (as tea, toast-water, barley-water, and weak broth). Small quantities of milk and farinaceous matters (in the form of bread, arrow-root, or tapioca, gruel, and light pudding) are sometimes permitted. The terms *thin diet*, *spoon diet*, *fever diet*, *simple diet*, and *broth diet*, are applied to particular modifications of low diet.

5. Full or Common Diet.—On many occasions where it is desirable to restore or support the powers of the system, patients are permitted to satisfy their appetite for plain vegetable and animal food. In many indolent diseases, in scrofula, in some affections of the nervous system (as chorea and epilepsy), and in the stage of convalescence after acute diseases, &c. this kind of diet is frequently directed. In these cases beer is usually permitted. Wine, and even ardent spirit, are sometimes required. In some diseases of, and in accidents occurring in, confirmed drunkards, it is frequently found injurious to withhold the stimulus to which the patient's system has been long accustomed; and thus wine, brandy, rum, or gin, is ordered, according to circumstances.

In concluding these remarks on the subject of dietetical regimen, I have thought it advisable to give a tabular view of the Diets employed at the different hospitals of this metropolis[c].

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[c] The Diet-Tables of the County, Scotch, and Irish hospitals, will be found in Dunglison's *New Dictionary of Medical Science*, art. Diet, vol. i. p. 299. Boston, U. S. 1833.

DIET-TABLES OF THE LONDON HOSPITALS.

⁂ In addition to the substances specified in the following Tables, other articles (as chops, steaks, fish, wine, spirit, porter, &c.) are permitted, when specially ordered by the medical officers. These are denominated *extras.*

LONDON HOSPITAL.

	COMMON DIET.	MIDDLE DIET.	LOW DIET.	MILK DIET.
Per Day	12 oz. Bread. 1½ pts. Beer, *Men.* 1 pint, *Women.*	The same, except that 4 oz. of Meat shall be given, instead of 8 oz.	8 oz. Bread.	12 oz. Bread.
Breakfast	Gruel.		Gruel.	Gruel.
Dinner	8 oz. Beef, with Potatoes, thrice a week. 8 oz. Mutton, with Potatoes, twice a week. 8 oz. Potatoes, & Soup, with Vegetables, twice a week.		Broth.	1 pint Milk.
Supper	1 pint of Broth.		Gruel or Broth.	1 pint Milk.

ST. BARTHOLOMEW'S HOSPITAL.

	MEAT DIET.	BROTH DIET.	THIN OR FEVER DIET.	MILK DIET.
Daily	Milk Porridge. 12 oz. Bread. 6 oz. Muttⁿ or Beef 1 pt. Broth [with Peas or Potatoes, 4 times a week]. 2 pts. Beer, *Men.* 1 pint, *Women.* 1 oz. Butter, twice a week.	Milk Porridge. 12 oz. Bread. 2 pints Broth. 1 pint Beer. 1 oz. Butter.	Milk Porridge. 12 oz. Bread. 1 pint of Milk, with Tapioca, Arrow-root, Sago, or Rice, as may be prescribed. Barley-water.	Milk Porridge. 12 oz. Bread. 2 pts. Milk, with Tapioca, Arrow-root, Sago, or Rice, as may be prescribed. Barley-water. 1 oz. Butter. Bread Pudding, 3 times a week, when ordered.

GUY'S HOSPITAL.

	FULL DIET.	MIDDLE DIET.	LOW DIET.	MILK DIET.	FEVER DIET.
Daily	14 oz. Bread. 1½ oz. Butter. 1 quart Table Beer. 8 oz. Meat, when dressed.	12 oz. Bread. 1½ oz. Butter. 1 pt. Table Beer. 4 oz. Meat, when dressed, and ½ pint Broth.	12 oz. Bread. 1 oz. Butter. Tea & Sugar.	12 oz. Bread. 1 oz. Butter. 2 pints Milk.	6 oz. Bread. 1 oz. Butter. Tea & Sugar.
			Half a pound of Beef (for Beef-tea), or Arrow-Root or Sago, when ordered.		

For each diet, Gruel or Barley-Water, as required.

NORTH LONDON HOSPITAL.

	FULL DIET.	MIDDLE DIET.	LOW DIET.	MILK DIET.
Daily	16 Bread. ¼ pint Milk. ½ lb. Meat and ½ lb. Potatoes four days. 1 pint Soup or Rice three days.	16 oz. Bread. ¼ pint Milk. 1 pint Soup or Rice.	8 oz. Bread. ¼ pint Milk. Oatmeal for Gruel.	16 oz. Bread. 2 pints Milk.

ST. THOMAS'S HOSPITAL.

	FULL DIET.	MILK DIET.	DRY DIET.	FEVER DIET.
Daily	2 pints of Beer, 14 oz. of Bread.	12 oz. of Bread.	14 oz. of Bread, 2 pints of Beer.	12 oz. of Bread, 2 pints of Beer.
Breakfast	Water Gruel.	1 pint of Milk.	Water Gruel.	Water Gruel.
Dinner	½ lb. of Beef, when dressed, twice a week; 4 oz. of Butter, or 6 oz. of Cheese, thrice a week; ½ lb. of Mutton, when boiled, thrice a week.	1 pint of Milk four times a week, Rice Pudding thrice a week.	4 oz. of Butter, four times a week; Rice Pudding and 4 oz of Butter, three times a week.	¾ of a lb. of Beef for tea.
Supper	1 pint Broth, four times a week.	1 pint of Milk.		

ST. GEORGE'S HOSPITAL.

	EXTRA DIET.	ORDINARY DIET.	FISH DIET.	FEVER DIET.	BROTH DIET.	MILK DIET.
Daily	12 oz. Bread. *Men,* 2 pints Beer. *Women,* 1½ pints Beer.	12 oz. Bread. 1 pint Beer.	12 oz. Bread.	12 oz. Bread. Barley Water *ad libitum.*	12 oz. Bread.	12 oz. Bread.
Breakfast	1 pint Tea. ¼ pint Milk.	1 pint Tea. ¼ pint Milk.	1 pint Tea, ¼ pint Milk	1 pint Tea. ¼ pint Milk.	1 pint Tea. ¼ pint Milk.	1 pint Tea. ¼ pint Milk.
Dinner	12 oz Meat, roasted (weighed with the bone before it is dressed) four days,—boiled three days. ½ lb. Potatoes.	One half the meat allowed for extra diet. ½ lb. Potatoes.	4 oz. of plain boiled white fish (as Whiting, Plaice, Flounders, or Haddock).	Arrow-root, &c. must be especially ordered.	1 pint Broth 6 oz. light Pudding.	1½ pints Rice Milk four days. ½ lb. Bread or Rice Pudding three days.
Supper	1 pint Gruel. ¼ pint Milk.	1 pint Gruel. ¼ pint Milk.	1 pint Gruel. ¼ pint Milk.	1 pint Tea. ¼ pint Milk.	1 pint Gruel. ¼ pint Milk.	½ pint Milk.

WESTMINSTER HOSPITAL.

	FULL DIET.	MIDDLE DIET.	LOW DIET.		SPOON, OR FEVER DIET.	INCURABLES' DIET.
			Fixed.	*Casual.*		
Daily	14 oz. Bread.	10 oz. Bread.	½ lb. Bread.	—	¼ lb. Bread.	¾ lb. Bread. ½ lb. Meat. ½ lb. Potatoes. ¼ pint Milk. 1 pint Porter.
Breakfast	1 pint Milk Porridge, or Rice Gruel.	1 pint Milk Porridge, or thin Gruel.	1 pint Tea, with Sugar and Milk.	—	1 pint Tea, with Sugar and Milk.	
Dinner	½ lb. Meat roasted, boiled, or chops. ¾ lb. Potatoes.	¼ lb. Meat, roasted, boiled, or chops. ¾ lb. Potatoes.	No fixed Diet for Dinner.	1 pint of Broth, or ½ lb. of Bread, or Rice Pudding, or 1 Pint Beef Tea, or a Chop, or Fish.	Barley Water.	
Supper	1 pint Milk Porridge, or Rice Gruel.	1 pint Milk Porridge, or thin Gruel.	1 pint Tea, with Sugar and Milk.	—	1 pint Tea, with Sugar and Milk.	

MIDDLESEX HOSPITAL.

	DIÆTA CARNIS OR MEAT DIET.	DIÆTA JUSCULI OR SOUP DIET.	DIÆTA LACTIS OR MILK DIET.	DIÆTA SIMPLEX OR SIMPLE DIET.	CANCER DIET.
Daily	12 oz. Bread.	12 oz. Bread.	12 oz. Bread.	6 oz. Bread.	12 oz. Bread. ½ lb. Meat. ½ lb. Potatoes 1 pint Milk.
Breakfast	1 pint Milk.	1 pint Milk.	1 pint Milk.	1 pint Barley Water.	
Dinner	*Physicians' Patients.* ½ lb. Potatoes, 4 oz. dressed meat (beef or mutton), roast and boiled alternately, 4 days. 4 oz. Meat in Soup, 3 days. *Surgeons' Patients.* ¾ lb. Potatoes, 4 oz. dressed Meat (Beef or Mutton), roast and boiled alternately.	1 pint Soup, made with 4 oz. Beef, alternately with 1 pint of Broth with Barley.	½ pint Milk with Rice Pudding, 4 days, and with Batter Pudding 3 days.	1 pint Gruel.	
Supper	1 pint Gruel alternately, with 1 pint of Barley Water.	1 pint Gruel.	½ pint Milk, or 1 pint of gruel.	1 pint of Gruel or Barley Wawater.	

KING'S COLLEGE HOSPITAL.

	FULL DIET.	MIDDLE DIET.	MILK DIET.	LOW DIET.	FEVER DIET.
Daily	1 pint Beer, or ½ pint Porter. 14 oz. Bread.	14 oz. Bread.	1 lb. Bread.	8 oz. Bread.	—
Breakfast	1 pint Milk Porridge.	1 pint Milk Porridge.	1 pint Milk.	1 pint Gruel.	1 pint Gruel.
Dinner	½ lb. Meat. ½ lb. Potatoes.	¼ lb. Meat. ½ lb. Potatoes.	1 pint Milk.	1 pint Broth.	2 pints Barley Water.
Supper	1 pint Milk Porridge.	1 pint Milk Porridge.	1 pint Gruel.	1 pint Milk Porridge.	1 pint Milk Porridge.

2. EXERCITATIO.—EXERCISE.

(Gymnastics.)

Exercise is an important hygienic agent. Its proper consideration, however, requires far more space than can be devoted to it in this work. I must, therefore, content myself with a few remarks on its general effects, and refer the reader to some treatises in which it is more fully considered.

Though the word exercise, in its most extensive signification, has reference to the action of all the organs of the animal economy, yet it is usually limited to those of locomotion; and in this sense I employ it.

The exercise of the muscular system is followed by several marked effects:—of these, the first to be noticed are *mechanical*. Whenever the muscles are called into activity, they exert a local influence, of a mechanical kind, on the blood-vessels in their immediate vicinity, and accelerate the circulation of the blood. This is followed by an augmentation of the animal heat; and, if the exercise be of a kind to call into activity a considerable number of muscles, the general circulation soon participates in the effects; the pulse is quickened, and the respiration and secretion are augmented. Another effect, which, in its origin, is probably of a mechanical nature, is the absorption of the fat between the muscles and their fasciculi. It seems to arise from the pressure exerted by the contracted muscle on the soft tissues immediately around it.

A second class of effects caused by muscular action may be denominated *organic* or *vital*. I refer now to the augmentation of volume, firmness, and elasticity, and increase of strength or power, which a muscle acquires from frequent but moderate use. Blacksmiths, fencers, and prize-fighters, furnish excellent illustrative examples of these effects.

But the action of the muscles can only be effected through the medium of the nervous centres and nerves. So that the latter are called into activity, and through them the whole system becomes influenced, when a number of muscles is exercised. These effects may be denominated *nervous*.

The fourth and last class of effects to be referred to, may be called *psychical* or *mental*[c]. To this belong the different mental effects produced by agreeable and disagreeable,—by voluntary and compulsory,—exercises. Employed moderately, agreeable exercise acts as a salutary excitant to the intellectual faculties and sensations. I agree with Dr. James Johnson[d], " that travelling exercise, while it so much improves all the bodily functions, unhinges and unfits the mind, *pro tempore*, for the vigorous exercise of its higher faculties." But the first excitement being over, " the memory of scenes and circumstances, together with the reflections and recollections attendant thereon, furnish an ardent mind with rich materials and trains of thought, that may, by gifted individuals, be converted into language; and thus conveyed to thousands."

Thus, then, it appears that exercise, employed moderately, has a tonic and stimulating influence on the system, and is calculated to be beneficial in a great variety of complaints. Used immoderately, it exhausts both the mental and bodily powers, and produces great debility. In fever, in vascular excitement or inflammation of the brain, in inflammatory affections of the lungs, in maladies of the circulating organs (especially dilatation of the cavities of the heart, diseased valves, and aneurism), in violent hemorrhages, gastro-enteritic inflammation, acute rheumatism, &c., muscular exertion is manifestly injurious; repose and inaction being indicated. In sprains and lacerations of the muscles, in fractures and dislocations, &c., it is obviously improper. In hernia, or a tendency thereto, great muscular exertion must be carefully avoided.

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[c] See p. 4.

[d] *Change of Air, or the Pursuit of Health and Recreation*, 4th ed. 1838.

Exercises may be divided into the *active*, the *passive*, and the *mixed*. To the first belong walking, running, leaping, dancing, fencing, wrestling, &c.; to the second are referred, carriage exercise and sailing; while horse-exercise belongs to the third or last division[e].

3. CLIMATE.

Under the word Climate are included those topographical, atmospheric, and other conditions of a region or country, which have a beneficial or injurious influence on the health and lives of the inhabitants.

It is probable that we are yet ignorant of many circumstances which contribute to give the climatic character to a place; and, of those that are known, it is often not easy to define the separate influence of each.

The most obvious circumstances which affect the climate of a region or country, are *temperature*, *humidity*, *purity of the atmosphere*, *wind*, *atmospheric pressure*, *intensity of light*, and *atmospheric equability* or *vicissitudes*.

1. TEMPERATURE.—In considering the temperature of a place, we must regard, not merely its annual mean, but its extremes. Inland tracts of country experience greater extremes than the coasts. This arises from land being more rapidly heated and cooled than water. Hence it attains a higher temperature in summer,—and a lower one in the winter. It also deserves notice that the western coasts of the extra-tropical continents have a much higher mean temperature than the eastern coasts. This is explained by the heat evolved in the condensation of vapour, swept from the surface of the ocean by the eastern winds[f]. The effects of heat and cold on the human body have been already considered[g]. *Warm climates* are adapted for pulmonary invalids (especially consumptive patients), the rheumatic, the scrofulous, and the paralytic. *Cold*, or rather *moderately cool*, climates are bracing, and are fitted for relaxed constitutions.

2. HUMIDITY. *Hygrometric State of the Atmosphere.*—Evaporation from the cutaneous and pulmonary surfaces is augmented by a dry state of the atmosphere, and checked by a damp or moist state. But the transudation which depends on vital action is augmented by a warm moist atmosphere[h]. "Of all the physical qualities of the air," observes Sir James Clark[i], "humidity is the most injurious to human life." A *moist*, or rather a *soft*, climate promotes vital transudation, and, therefore, is adapted for chronic bronchitis of a dry irritable kind, frequently denominated dry catarrh, and for some other maladies attended with a harsh, dry, parched skin. A *dry* climate, on the other hand, checks vital transudation, and, therefore, is better fitted for relaxed, languid constitutions, with profuse secretion and exhalation; as humid asthma, and those forms of chronic catarrh accompanied with copious expectoration.

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[e] For further information on the subject of Exercise, the reader is referred to Celsus, lib. i. cap. 2, and lib. ii. cap. 15; Sir J. Sinclair's *Code of Health and Activity*, Edinb. 1807; Dunglison's *Elements of Hygiène*, Philadelphia, 1835; *Dict. de Médecine*, art. *Gymnastique; Dict. de Médecine et de Chirurgie pratiques*, art. *Gymnastique; Manuel d'Education physique, gymnastique et morale*, par le Colonel Amoros. Paris, 1830.

[f] Daniell's *Meteorological Essays*, p. 105, 2d ed. Lond. 1827.

[g] See pp. 8 and 21.

[h] Edwards, *De l'Influence des Agens Physiques*, p. 338. Paris 1824.

[i] *The Sanative Influence of Climate*, 3d ed. Lond. 1841.

3. Purity of the Atmosphere.—A pure condition of the atmosphere is an essential element of all healthy climates. The greater mortality of cities than of the country is principally referrible to the respiration of air vitiated by the congregation of a large number of persons in a comparatively limited space. Emanations from the soil, and from decomposing organic matter, also contribute to the contamination of atmosphere[j]. The injurious effect of fogs on pulmonary invalids is well known to every one. Curiously enough, however, some patients affected with spasmodic asthma breathe better in a smoky atmosphere (as that of London) than in pure air.

4. Wind.—Wind greatly modifies the effect of temperature on the body. Thus two successive days, whose temperature, as indicated by the thermometer, may be the same, shall produce in us—the one a sensation of warmth, in consequence of the calm, still, condition of the air,—while the other creates a feeling of cold, from the presence of a violent wind. So that, as Sir James Clark[k] has justly observed, "the influence of temperature on the living body is indicated much more accurately by our sensation than by the thermometer." Moreover, the humidity and the purity of the atmosphere are greatly modified by the motion or calmness of the air. The precise effects produced on climates by wind, must of course depend on its direction, violence, &c.

5. Atmospheric Pressure.—Diminished atmospheric pressure promotes evaporation. Elevated regions, therefore, are colder, drier, more bracing, and, *cæteris paribus*, better adapted for relaxed individuals, with profuse secretion and exhalation, than the opposite localities: but, on the other hand, they are injurious in bronchial or tracheal irritation, with diminished secretion.

In extra-tropical climates, a fall in the barometer, without a change or rise of wind, is usually followed by rain. Now, a humid condition of the atmosphere checks evaporation, while the reduced barometrical pressure augments it. Hence, we have two opposing influences in operation. This condition of the air induces a feeling of languor and fatigue, and gives rise to sweating on the slightest exertion.

6. Intensity of Light.—The influence of light has been already considered[l].

7. Atmospheric Equability or Vicissitudes.—Rapid atmospheric changes are always injurious to health. Invalids, and those with delicate constitutions, often appreciate the slightest alterations in the condition of the atmosphere, and which are not observable by the healthy and the robust.

These are some only of the circumstances which affect the quality or character of a climate. Others doubtless exist; but their precise nature and influence have scarcely been ascertained. For example, we have yet to learn the influence of Electricity and Magnetism on the climate of a place.

I propose, now, to glance at the characters of those climates most commonly resorted to by invalids for therapeutical purposes. In doing so, I beg to acknowledge the great assistance I have received from the valuable work of Sir James Clark, to which I must refer the reader for further details.

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[j] The production of Ague, by the exhalations from stagnant water and marshy soils, is well known to every one. My friend, Professor Daniell (*Lond. Edinb. and Dubl. Phil. Mag.* July 1841), has shown that the waters upon the Western coast of Africa, to an extent of 40,000 square miles, are impregnated with sulphuretted hydrogen, to an amount, in some places, exceeding that of some of the most celebrated sulphur springs of the world; and he suggests that the existence of this deleterious gas in the atmosphere, which must necessarily accompany its solution in the waters, may be connected with the awful miasma, which has hitherto proved fatal to the explorers and settlers of the deadly shores of Africa; as well as of other places.

The origin of sulphuretted hydrogen in sea, and some other waters, has been ascribed, by Dr. Marcet (*Phil. Trans.* 1819, p. 195), Mr. Malcomson (*Trans. of the Geological Society*, 2d Ser. vol. v. p. 564, Lond. 1840), Dr. A. Fontan (*Ann. de Chem. et de Phys.* July 1840), and Professor Daniell (*op. supra cit.*), to the decomposition of sulphates of the waters, by putrifying vegetable matter.

[k] *Op. supra cit.* p. 156.

[l] See p. 5.

Climates may be conveniently arranged as follows:—

1. Climates of England.
2. Climates of France.
3. Climates of Spain and Portugal.
4. Climates of Italy, and the Mediterranean.
5. Climates of the Atlantic.

1. *Climates of England.*

"The British Islands are situated in such a manner as to be subject to all the circumstances which can possibly be supposed to render a climate irregular and variable. Placed nearly in the centre of the temperate zone, where the range of temperature is very great, their atmosphere is subject, on one side, to the impressions of the largest continent of the world; and, on the other, to those of the vast Atlantic Ocean. Upon their coasts the great stream of aqueous vapour, perpetually rising from the western waters, first receives the influence of the land, whence emanate those condensations and expansions which deflect and reverse the grand system of equipoised currents. They are also within the reach of the frigorific effects of the immense barriers and fields of ice, which, when the shifting position of the sun advances the tropical climate towards the northern pole, counteract its energy, and present a condensing surface of immense extent to the increasing elasticity of the aqueous atmosphere[m]."

Sir James Clark thus arranges the climates of England:—

1. London.
2. The South Coast.
3. South-west Coast.
4. Cornwall, Land's End.
5. West of England.

1. London.—The mean annual temperature of London somewhat exceeds that of the suburban parts. "The excess of the temperature of the city varies through the year, being least in spring, and greatest in winter; and it belongs, in strictness, to the nights, which average 3·7° warmer than in the country; while the heat of the day, owing, without doubt, to the interception of a portion of the solar rays by a constant veil of smoke, falls, on a mean of years, about a third of a degree short of that in the open plain[n]." Hence in the winter, delicate invalids sometimes experience benefit in coming to London from the country. But the impure state of the atmosphere generally counterbalances these good qualities[o]. In some cases of spasmodic asthma, however, respiration is easier in London than in the country.

2. South Coast.—This comprehends the tract of coast between Hastings and Portland Island. Its mean annual temperature is about

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[m] Daniell's *Meteorological Essays*, p. 114. 2nd ed. 1827.

[n] See Luke Howard's *Climate of London*, 1818-20. 2nd ed. 1833.

[o] For further details respecting the Climate of London, consult Professor Daniell's *Essay* on this subject. Also, Dr. Bateman's *Reports of the Diseases of London*. Lond. 1819.

that of London; but the summers are somewhat cooler, and the winters somewhat warmer, than the corresponding seasons of the metropolis[p].

The principal places of resort for invalids, on this line of coast, are the following:—

a. HASTINGS.—A mild winter residence; placed low and well protected from the northerly winds. Sir James Clark[q] regards its climate "as somewhat intermediate between that of Devonshire and Clifton; less warm, but also less relaxing than the former. It is about the same temperature; but less dry and bracing than the latter, and it is inferior to it as a spring climate." It is well adapted for pulmonary invalids during the months of December, January, and February. The distinguished author above quoted declares, that it "is unfavourable in nervous complaints, more especially in nervous headaches connected with, or entirely dependent upon, an irritated condition of the digestive organs, and also in cases where a disposition to apoplexy or epilepsy has been manifested."

St. Leonards is about a mile from Hastings, and possesses a similar climate.

b. BRIGHTON.—The air is dry and bracing. The climate is most beneficial during autumn and the early part of winter, when it is milder and more steady than that of Hastings. It is adapted for relaxed individuals, with copious secretion and exhalation. It usually agrees well with children (especially those of a scrofulous habit) and convalescents.

c. ISLE OF WIGHT.—*Undercliff* presents an agreeable, mild, sheltered, dry, bracing climate, well adapted for the residence of many pulmonary and other delicate invalids throughout the year. It differs from the climate of Torquay (which is soft, humid, and relaxing) by its dry and bracing qualities. Hence it is suited for relaxed constitutions, with copious secretion. *Cowes and Ryde* are delightful summer residences.

d. SOUTHAMPTON.—This part of the coast is objectionable, on account of its temperature being equally variable with that of the environs of London.

3. SOUTH-WEST COAST.—This comprehends the tract of coast extending from Portland Island to Cornwall. Its general qualities are those of a mild, soft, humid climate, soothing but somewhat relaxing. It is adapted to pulmonary affections, especially those which are dry and unaccompanied with much expectoration. In dyspepsia, with symptoms of irritation or inflammation, constituting the gastritic dyspepsia of Sir James Clark, it is also beneficial. But in all forms of chronic diseases, with copious secretion and exhalation, and a languid and relaxed state of the constitution, it is injurious.

The following are the principal places of resort for invalids along the South-West Coast:—

a. SALCOMBE.—The Montpelier of Huxham. The warmest spot of this coast.

b. TORQUAY.—This is drier than the other parts of this coast, though its general character is soft and humid.

c. DAWLISH.—Next in dryness to Torquay.

d. EXMOUTH.—The higher parts of the town exposed to winds; the lower parts liable to occasional damp. Sir J. Clark declares that it is not adapted for persons with delicate chests.

e. SALTERTON.—Preferable to Exmouth. It is well protected from winds, especially the northerly ones.

f. SIDMOUTH.—Damp.

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[p] For the character of this part of England consult Dr. Harwood's *Curative Influence of the Southern Coast of England, especially that of Hastings; with Observations on Diseases, to which a Residence on the Coast is most beneficial.* Lond. 1828.

[q] *Op. supra cit.* p. 177.

4. SOUTH COAST OF CORNWALL. *Land's End.*—In its general characters this climate resembles that of the south coast of Devon. From the latter, however, it differs, in its greater humidity, and in being more exposed to winds. It is, consequently, more relaxing. The class of cases in which it is calculated to be beneficial or injurious, are much the same as those for the south coast of Devon[r].

The following are the chief places of residence for invalids along this coast:—

a. PENZANCE.—Exposed to the north-east winds during the spring months.

b. FALMOUTH.—The winter temperature is a trifle lower than that of Penzance.

5. WEST OF ENGLAND.—Under this head are grouped the places along the borders of the British Channel and the æstuary of the Severn. The mean temperature of this group is, during the winter, rather lower, but in March and April rather higher, than that of the south coast.

CLIFTON.—This is the mildest and driest climate in the West of England. It is bracing, and well adapted for scrofulous and relaxed constitutions, with copious secretion and exhalation.

2. *CLIMATES OF FRANCE.*

The southern climates of France resorted to by invalids, may be divided into those of the South-West, and those of the South-East of that country.

1. SOUTH-WEST OF FRANCE.—According to Sir James Clark the climate of this part of France is soft, relaxing, and rather humid; resembling in its general qualities that of the south-west of England. It is favourable to phthisical invalids, for those labouring under bronchial affections, with little expectoration, and for other chronic cases attended with a dry skin.

a. PAU.—Dr. Playfair[s] thus sums up the qualities of this climate. "Calmness, moderate cold, bright sunshine of considerable power, a dry state of atmosphere and of the soil, and rains of short duration. Against these must be placed,—changeableness, the fine weather being as short-lived as the bad; rapid variations of the atmosphere within moderate limits. In autumn and spring there are heavy rains."

b. BAGNÈRES DE BIGORRE, in the department of the High Pyrenees, has a mean temperature, during the months of June, July, August, and September, of 66° F. Dr. Wm. Farr[t] declares the climate to be anti-irritating and moist, and to be favourable to the consumptive. Its season is from June to September.

2. SOUTH-EAST OF FRANCE.—Sir J. Clark says the general character of the climate is dry, hot, and irritating. It is adapted for torpid, relaxed habits, but is decidedly improper for the consumptive and those labouring under irritation and inflammation of the air-tubes.

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[r] On the climate of this part of England, consult Dr. Forbes's *Observations on the Climate of Penzance and the District of the Land's End.* Penzance, 1820.—Also his *Medical Topography of the Land's End,* in the *Provincial Medical Transactions,* vol. ii.

[s] Sir J. Clark's *Sanative Influence of Climate,* p. 192.

[t] *A Medical Guide to Nice.* Lond. 1841.

a. MONTPELIER.—Long but undeservedly celebrated as a residence for phthisical invalids.

b. MARSEILLES.—Exposed to cold winds. Soil dry and arid.

c. HYERES.—Sir J. Clark declares it to be the least exceptionable residence in Provence for the pulmonary invalid.

3. *CLIMATES OF PORTUGAL AND SPAIN.*

Precise information respecting the climates of these countries, to which pulmonary invalids occasionally resort, is much to be desired.

1. PORTUGAL.—Dr. Bullar[u] states that the mean annual temperature of *Lisbon* is 12° F. higher than that of London; and that the mean temperature of its winter is 16° F. higher than that of London. But notwithstanding its mildness, it is objectionable for persons affected with phthisis, on account of the inequality of its temperature.

2. SPAIN.—*Biscay* is subject to sudden and extraordinary changes in temperature; the mercury having been known to rise and fall from 3° to 4° F. within a few minutes[w]. This must, of course, make it an unfit residence for pulmonary invalids. *Madrid* is elevated more than 300 fathoms above the level of the sea. Its annual mean temperature is 59° F.[x] *Cadiz*, being nearly surrounded by the sea, has a comparatively temperate climate.

4. *CLIMATES OF ITALY AND THE MEDITERRANEAN.*

The climates included under this head are exceedingly diversified, so that it is difficult to lay down any general character of them.

a. NICE.—The climate of this place is somewhat similar to that of the South-East of France. It is mild, equable, and dry; being adapted for torpid, relaxed individuals, with abundant secretion from the mucous membranes. Dr. William Farr[y] says, the great objection to it is its dryness, and the exciting and irritating nature of its atmosphere. It is beneficial in chronic bronchitis, with copious expectoration,—in chronic rheumatism,—scrofula,—gout, and atonic dyspepsia.

b. GENOA.—Climate dry and healthy, with a sharp exciting air. It is adapted for relaxed constitutions, but is unfit for phthisical invalids.

c. FLORENCE.—Not favourable for invalids.

d. PISA.—According to Sir James Clark, the climate "is genial, but rather oppressive and damp. It is softer than that of Nice, but not so warm; less soft, but less oppressive, than that of Rome." Pisa is frequented by consumptive invalids.

e. ROME.—The climate of this city is one of the best in Italy. Sir James Clark characterises it as being mild, soft but not damp, rather relaxing and oppressive, and remarkable for the stillness of its atmosphere. It is well adapted for phthisis, bronchial affections of a dry irritating kind, and chronic rheumatism.

f. NAPLES.—The climate of Naples is warm, variable, and dry. Sir James Clark compares it to that of Nice, but states that it is more changeable, and, if softer in the winter, is more humid. Dr. Cox[z], however, declares that the mean diurnal variation is far less than is generally supposed. It is an unsuitable residence for most pulmonary invalids, especially those affected with tubercular phthisis. In bronchial cases, with profuse secretion, benefit is sometimes obtained from it. In general debility and deranged health, it is also serviceable. Dr. Cox says it is beneficial in dyspepsia, rheumatic neuralgia, and scrofula.

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[u] *A Winter in the Azores.* Lond. 1841.

[w] Inglis, *Spain in* 1830, vol. i. p. 39. Lond. 1831.

[x] Humboldt, in De Laborde's *View of Spain*, vol. i. p. clxiii. Lond. 1809.

[y] *A Medical Guide to Nice*, p. 10. Lond. 1841.

[z] *Hints for Invalids about to visit Naples*, p. 17. Lond. 1841.

g. MALTA.—The climate of Malta is mild, dry, bracing, and pretty equable. It is serviceable in chronic bronchitis [with profuse secretion], scrofula, dyspepsia, and hypochondriasis.

5. *ATLANTIC CLIMATES.*

The climates of the Atlantic islands, resorted to by invalids, may be arranged in two groups,—the one eastern, the other western.

1. EASTERN ATLANTIC.—This group includes Madeira, the Canaries, and the Azores.

a. MADEIRA.—The climate of Madeira is mild, humid, equable, and steady. Sir James Clark regards it as the finest in the northern hemisphere. It is superior to all other climates for incipient phthisis. This superiority consists in the mildness of the winter, the coolness of the summer, and the remarkable equality of the temperature during the night and day, as well as throughout the year. Experience, moreover, seems to have fully demonstrated the advantage which patients, with incipient symptoms of consumption, derive from a residence in this island[a].

b. THE CANARIES.—*Teneriffe* is the only island of this group possessing accommodation for invalids. Though its mean annual temperature is higher than that of Madeira, its equability is less.

c. THE AZORES OR WESTERN ISLANDS.—Dr. Bullar declares these to be "rather colder than Madeira, and somewhat more equable, and perhaps more humid; but they have not at present those accommodations for strangers which the latter island possesses, nor have they communications by steam with England[b]." *St. Michaels*, the largest of the Azores, has a mild, humid, equable climate.

2. WESTERN ATLANTIC.—This group includes the Bermudas, the Bahamas, and the West Indies. It is more subject to rapid changes of temperature than the Eastern Atlantic group.

a. THE BERMUDAS.—The climate is warm, variable, and dry. The mean annual temperature is considerably higher than that of Madeira; but the climate is variable and windy during the winter, and hot and oppressive in the summer (Sir J. Clark).

b. THE BAHAMAS.—The climate is warm, but is subject to rapid changes of temperature. Dry cold winds prevail. Hence the Bahamas are unsuited to consumptive invalids.

c. THE WEST INDIES.—The temperature of these islands is too high, and its variations too great, to admit of their being a desirable residence for patients affected with pulmonary consumption; but as a prophylactic for those predisposed to this disease, it is highly spoken of. In scrofula, the climate proves beneficial. Calculous complaints and ossific deposits are rare. The most healthy islands of the group are *Jamaica, Barbadoes*, *St. Vincent's*, *Antigua*, and *St. Kitt's*.

The diseases for which change of climate is most frequently resorted to are—

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[a] For further information respecting the medical qualities of the island of Madeira, the reader may refer with great advantage to Sir James Clark's work, before cited; Dr. Gourlay's *Observations on the Natural History, Climate, and Diseases of Madeira*, 1811; Dr. Renton, in the *Edinburgh Medical and Surgical Journal*, vol. xxvii. 1817; and Dr. Heineken's paper in the *Medical Repository*, vol. xxii. 1824.

[b] *A Winter in the Azores.* Lond. 1841.

1st. *Pulmonary Complaints*, especially Phthisis, Chronic Bronchitis resembling Phthisis, Asthma, Hemoptysis, and Diseases of the Larynx and Trachea.
2. *Dyspeptic and Hypochondriacal Complaints.*
3. *Chronic Rheumatism.*
4. *Scrofula.*
5. *Urinary Diseases.*
6. *Liver Complaints.*
7. *In the Convalescence from Fever, and other acute maladies.*

1. *PULMONARY COMPLAINTS.*—These maladies are benefited by removal from a colder to a warmer climate. Equability, purity, and calmness of the atmosphere, are other desirable qualities in a climate for pulmonary invalids. The nature of the malady and constitution of the patient, however, render all climates possessed of these qualities not equally suited for every case.

a. PHTHISIS.—" For such consumptive patients," observes Sir James Clark, " as are likely to derive benefit from climate, I consider that of *Madeira* altogether the best. *Teneriffe* and the *Azores* approach most nearly in the character of their climate to Madeira. Of the climates of the South of France and Italy the same experienced writer says, when " there exists much sensibility to harsh and keen winds, and, more especially, if immediate vicinity to the sea-coast is known to disagree, *Rome* or *Pisa* is the best situation for a winter residence. When, on the contrary, the patient labours under a languid feeble circulation, with a relaxed habit, and a disposition to congestion or to hemorrhage, rather than to inflammation ; and, more especially, when the sea air is known by experience to agree, *Nice* deserves the preference." Late experience has shewn, that *Montpelier*, *Marseilles*, and other places in the south-east of France, once celebrated as affording a good winter climate for consumptive patients, are decidedly improper for phthisical invalids. Of English climates, those of *Undercliff*, *Torquay*, and *Hastings*, are best adapted for this disease. *Torquay* and *Penzance* disagree with persons of a relaxed habit. *Clifton*, during the spring months, often agrees well.

b. CHRONIC BRONCHITIS.—In relaxed constitutions, with copious expectoration, the climates of *Undercliff*, *Clifton*, *Brighton*, and *Nice*, are those which agree best. But, on the other hand, for dry, bronchial, and tracheal irritation, *Torquay*, *Madeira*, *Rome*, and *Pisa*, are to be preferred.

2. *DYSPEPSIA AND HYPOCHONDRIASIS.*—In selecting a climate for these complaints, we must attend to the character of the malady and the constitution of the invalid. Thus, in the atonic dyspepsia of relaxed and sluggish individuals, with copious secretions, we select a dry and bracing climate ; and in such, *Brighton*, *Clifton*, *Nice*, or *Naples*, would probably prove beneficial. But when the dyspepsia assumes an inflammatory form, with dry tongue and a febrile condition of system, the soft and humid climates are to be preferred,—such as *Torquay*, *Pau*, *Rome*, and *Pisa*.

3. *CHRONIC RHEUMATISM.*—In this malady, mild climates generally have been found beneficial. According to Sir James Clark's experience, *Rome* and *Nice* are the best climates on the continent. In relaxed and cachectic individuals, the latter place is to be preferred.

4. *SCROFULA.*—In this malady the *West Indies* prove highly serviceable. *Nice* and *Rome*, on the continent, have appeared to be favourable. In this country *Clifton* is perhaps the climate best adapted for scrofula.

5. *URINARY DISEASES.*—Warm climates relieve most affections of the urinary organs, especially calculous complaints, diabetes, and

vesical irritation. The benefit probably arises from the excitement of the skin and the abundant cutaneous secretion, and is to be explained on the principle of antagonism already alluded to[c]. In the *West Indies* calculous complaints are very rare.

6. *Liver Complaints.*—Various hepatic derangements are induced by a residence in tropical climates[d]; and in such cases benefit is obtained by a return to the more temperate climates of Europe.

7. In the *Convalescence* after fevers and inflammatory diseases, change of climate is often found highly beneficial.

III.—AGENTIA MECHANICA ET CHIRURGICA.—MECHANICAL AND SURGICAL AGENTS.

The consideration of these subjects does not fall within the province of this work.

IV. AGENTIA PHARMACOLOGICA SEU MEDICAMENTA.—PHARMACOLOGICAL AGENTS OR MEDICINES.

(Medicamina; Φάρμακα.)

Pharmacological Agents or Medicines are substances, not essentially alimentary, used in the treatment of diseases, and which, when applied to the body, alter or modify its vital actions.

Aliments are vital stimuli (see p. 5, foot-note), which vivify, and can themselves be vivified[e]; since they are assimulated to our organs, and become integrant parts of the living body.

Poisons are distinguished from medicines principally in the *degree* of their effects, and the *uses* to which they are applied; for the most powerful poisons become, when administered under proper regulations, very valuable medicines.

Pharmacology (*Pharmacologia*, from *φάρμακον*, *a medicine*; and *λόγος*, *a discourse*), or Materia Medica, is that branch of Acology devoted to the consideration of medicines.

α. General Pharmacology (*Pharmacologia generalis*) treats of medicines generally.

β. Special Pharmacology (*Pharmacologia specialis*) treats of medicines individually.

Pharmacology is divided into three departments, termed respectively *Pharmacognosy*, *Pharmacy*, and *Pharmacodynamics*.

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[c] See p. 9.
[d] See p. 10.
[e] See Müller's *Elements of Physiology*, by Baly, vol. i. p. 31.

1. PHARMACOGNOSIA.—PHARMACOGNOSY.

(Physiographische Arzneimittellehre, *Pfaff*[f]; Pharmaceutische Waarenkunde, *Goebel*[g]; Histoire des Drogues simples, *Guibourt*[h]; Pharmacomathie, *Cottereau*[i].)

PHARMACOGNOSY (from *φάρμακον, a medicine*; and *γιγνώσκω, I know*) is that department of Pharmacology which treats of the origin, properties, varieties, quality, and purity of Unprepared Medicines or Simples (*medicamenta cruda*).

In other words, Pharmacognosia treats of all that relates to the commerce of drugs.

Strictly speaking, it is a department of what the Germans call *Waarenkunde* (*Merchandize-Knowledge*); and hence is sometimes called *pharmaceutische Waarenkunde* (*pharmaceutical Merchandize-Knowledge*). As we have no word in the English language corresponding to Waarenkunde, I would suggest that of *Agorasmalogy* (from *ἀγόρασμα, merchandize*; and *λόγος, a discourse*).

Unprepared Medicines or Simples are either Foreign or Indigenous. The former are imported by the merchant, and sold on his behalf, by the drug-broker, to the wholesale druggist.

Much valuable information connected with the commerce of Foreign drugs will be found in the following works and periodicals:—

1. *A Dictionary, practical, theoretical, and historical, of Commerce and Commercial Navigation.* By J. R. M'Culloch, Esq. A new edition, with Supplement to Jan. 1839.
2. *Bill of Entry B.* published daily.
3. *Trade List and Weekly Register of Customs and Parliamentary Accounts.*—[The *London Medical Gazette* gives a monthly list of Drugs on sale, with their prices and several duties taken from the *Trade List.*]
4. *The Public Ledger.* A daily newspaper, containing the advertisements for the drug sales.
5. *Parliamentary Papers.* The following returns are especially useful to the pharmacologist:—
    - a. *A General Statement of the Imports and Exports of the principal Articles of Merchandize between the United Kingdom and the several Foreign Countries and British Possessions Abroad, in the year* 1827.
    - b. *A Statement of the Imports and Exports of the United Kingdom for the year* 1830, *ending 5th January,* 1831.
    - c. *A Statement of the Imports and Exports of the United Kingdom for the year* 1831, *ending 5th January,* 1832.

Indigenous vegetable substances are usually collected by the herbalist. Most of the plants grown in this country, and for which there is a large consumption, are cultivated at Mitcham, and other places.

In this country we have no recent works expressly devoted to Pharmacognosy. *The London* and *Edinburgh Dispensatories*, and Lewis's *Materia Medica*, contain a good deal of valuable information on this subject.

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[f] *System der Materia Medica,* 1er Band, S. 2. Leipzig, 1808.

[g] Goebel and Kunze's *Pharmaceutische Waarenkunde,* Eisenach, 1827-29.

[h] See his *Histoire Abrégée des Drogues Simples,* 3me éd. Paris, 1836.

[i] *Traité Elémentaire de Pharmacologie.* Paris, 1835.—*Pharmacomathie,* from *φάρμακον* and *μάθω, I seek,* or *inquire.*

The following are the best continental works on the subject:—

N. J. B. Guibourt's *Histoire Abrégée des Drogues Simples*, 3me éd. Paris, 1836.
T. W. C. Martius's *Grundriss der Pharmakognosie des Pflanzenreiches.* Erlangen, 1832.
T. W. C. Martius's *Lehrbuch der pharmaceutische Zoologie.* Stuttgart, 1838.
F. Goebel and G. Kunze's *Pharmaceutische Waarenkunde.* Eisenach, 1827-29.

2. PHARMACO-CHEMIA SEU PHARMACIA.—PHARMACEUTICAL CHEMISTRY OR PHARMACY.

(Chemische Arzneimittellehre, *Pfaff;* Pharmacotechnie, *Cottereau.*)

Pharmacy (from φάρμακον, *a medicine*) is that department of Pharmacology which treats of the preparation, compounding, preservation, and dispensing of medicines (*medicamenta præparata et composita*).

I must refer my readers to the following works for an account of the principles and operations of Pharmacy:—

R. J. Kane's *Elements of Practical Pharmacy.* Dublin, 1831.
N. E. Henry and G. Guibourt's *Traité de Pharmacie pratique et théorique.* 3me éd. par N. J. B. G. Guibourt. Paris, 1841.
E. Soubeiran's *Nouveau Traité de Pharmacie théorique et pratique.* 2nde éd. Paris, 1840.
J. A. Buchner's *Einleitung in die Pharmacie.* 3tte Aufl. Nürnberg 1827.

3. PHARMACO-DYNAMICA.—PHARMACODYNAMICS.

(Dynamische Arzneimittellehre, *Pfaff;* Pharmacodynamie, *Cottereau.*)

Pharmacodynamics (from φάρμακον, *a medicine*; and δύναμις, *power*) is that department of Pharmacology which treats of the effects and uses of medicines.

CHAPTER I.—ON THE MEANS OF ASCERTAINING THE EFFECTS OF MEDICINES.

Formerly the virtues of medicines were inferred from resemblances (fancied or real) in form, colour, &c. between these substances and parts of our organism. These marks or indications of medicinal power were called *Signatures*, and were supposed to arise from Astral influences[k].

Thus, Poppyheads were inferred to act on the head,—Elder-pith on the spinal marrow,—Euphrasia, or Eye-bright, on the eye,—Pulmonaria, or Lungwort, on the lungs,—Citrons on the heart,—Sow-bread on the stomach,—Cassia fistula on the bowels,—Aristolochia on the uterus,—and Orchis on the testicle,—because these substances resembled, respectively, the parts on which they were supposed to operate.—Again, Saffron was used in jaundice,—Lithospermum, or Gromwell, in calculous affections,—and Scrophularia in piles,—on account of the representation of the disease which each of these substances was fancied to bear.

There are four principal methods which, in modern times, have been resorted to for the purpose of determining the effects of medicines. These are founded, respectively, on—

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[k] See Sprengel, *Histoire de la Médecine*, t. iii. p. 321. Paris, 1815.—Also, Schroder's *Compleat Chymical Dispensatory*, by Rowland. Lond. 1669.

1. The *Sensible* qualities of medicines.
2. The *Natural-Historical* properties.
3. The *Chemical* properties.
4. The *Dynamical* properties.

1. THE SENSIBLE QUALITIES OF MEDICINES.—*Colour, Taste,* and *Odour,* have been used to indicate, in a very general way, the medicinal properties of plants. But to all the general positions which have hitherto been advanced concerning them, so many exceptions exist, that none possess much, if any, practical value.

It appears to me to be a waste of time and space to dwell on this subject; I shall, therefore, refer the reader, for further information, to the writings of Linnæus[l], Cullen[m], and Edwards and Vavasseur[n]. In another part of this work, I shall have occasion to notice Mr. Greeves's classification of the articles of the Materia Medica according to their sensible qualities. Some interesting information on the colour, odour, and taste of plants, is contained in Landgrebe's work on Light[o].

2. THE NATURAL-HISTORICAL PROPERTIES.—*Exterior Form* and *Structure* are made use of, in natural history, to determine the affinities of natural bodies: hence they are denominated *natural-historical properties.*

a. Of Minerals.—No conclusions, respecting the medicinal properties of minerals, can be deduced from crystalline form and structure.

If two dissimilar substances assume the same crystalline form, they are said to be *isomorphous:* and if the same substance be capable of crystallizing in two distinct forms, it is said to be *dimorphous.* Mr. Blake asserts[p], that the most striking points of resemblance exist generally between isomorphous compounds in their action on the animal tissues when *introduced into the blood.* Be this as it may, their action, when *taken into the stomach,* is often very dissimilar. Thus, the Triphosphate of Soda is isomorphous with the Triarseniate of the same base; but no one will pretend to assert that their action on the system is alike. Arsenious Acid is isomorphous with Sesquioxide of Antimony, yet their effects on the system are very dissimilar. Mr. Blake admits that the Salts of Lead and of Silver are exceptions to his statement: their action on the pulmonary tissue being analogous, though they are not isomorphous.

b. Of Vegetables.—The relations existing between natural-historical qualities and medicinal effects have been attentively examined with respect to vegetables. It has long been supposed, that those plants which resemble each other in their external appearances, are endowed with analogous medicinal properties. Cæsalpinus was, according to Dierbach[q], the founder of this doctrine; though Decandolle[r] regards Camerarius as the first who clearly announced it. Linnæus[s] says, "Plantæ quæ *genere* conveniunt, etiam virtute conveniunt; quæ *ordine* naturali continentur, etiam virtute propius accedunt; quæque *classe* naturali congruunt, etiam viribus quodammodo congruunt." I may also refer to Isenflamm, Wilcke, Gmelin, Jussieu, and Barton, as other supporters of this opinion. But the most important writer in favour of it is Decandolle, who, in 1804, published the first edition of his work on this subject; and, in 1816, a second edition of it appeared. In the year 1831, we had another interesting treatise on the same subject, by Dierbach. There are other writers, however, who deny altogether the possibility of judging of the virtues of plants by their exterior forms and botanical characters. Of these, it will be sufficient to mention Gleditsch[t].

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[l] *Philosophia Botanica,* p. 283, ed. 4^{ta}. 1787.

[m] *A Treatise of the Materia Medica,* vol. i. p. 138. Edinb. 1789.

[n] *Manuel de Matière Médicale.* Paris, 1831.

[o] *Ueber das Licht.* Marburgh, 1834.

[p] *Edinburgh Med. and Surg. Journ.* for July, 1841.

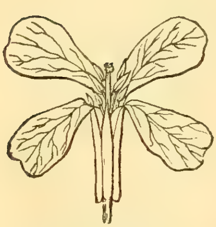
[q] *Abhandlung über die Arzneikräfte des Pflanzen, vergleichen mit ihrer Structur und ihren chemischen Bestandtheilen,* Lemgo, 1831.

[r] *Essai sur les Propriétés Médicales des Plantes,* p. 4, 2^{nde} éd. Paris, 1816.

[s] *Op. supra cit.* p. 278.

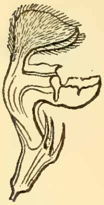
It must be admitted, that vegetable substances owe their peculiar qualities to the structure, and consequent action, of the organs producing them; and, therefore, that differences in the structure of an organ are attended with corresponding differences in the qualities of its products. It consequently follows, that the medicinal qualities of plants of the same natural order should be similar or analogous. That they are so to a certain extent is fully ascertained by numerous facts. If one vegetable species serve as nutriment for either animal or plant, we frequently observe that other species of the same genus, or even of a different genus, but of the same order, are also adapted for a like use; while, on the other hand, if any particular species be injurious, neighbouring species are likewise more or less so. Experience has fully proved, that in a very large number of instances there exists an analogy between the exterior forms and the medicinal properties of plants, so that we can sometimes predict the active principle and mode of operation of a vegetable, merely by knowing to what part of a natural arrangement it properly belongs. CRUCIFERÆ (fig. 3), for example, present the greatest uniformity in their botanical, chemical, and medicinal characters. They contain a volatile, acrid principle, which renders them stimulant; and, having been employed successfully in scurvy, they are frequently termed antiscorbutics. The LABIATÆ (fig. 4), which constitute, perhaps, the most natural family of the whole vegetable kingdom, contain a bitter, resinous, or extractive matter, and an etherial, aromatic, or volatile oil: which two principles, mixed in different proportions, are found in all the species, to which they communicate tonic and carminative properties. Neither Cruciferæ nor Labiatæ contain a single unwholesome or even suspicious species. In CONIFERÆ (fig. 5), we find the different species pervaded with an oleo-resinous juice, in consequence of which

FIG. 3.



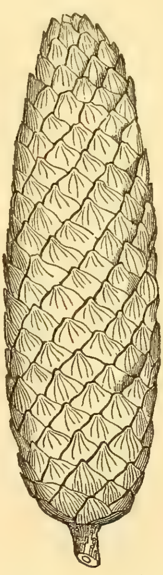
Raphanus sativus.
(CRUCIFERÆ.)

FIG. 4.



Glechoma hederacea.
(LABIATÆ.)

FIG. 5.



Picea vulgaris.
(Nees ab Esenbeck.)
(CONIFERÆ.)

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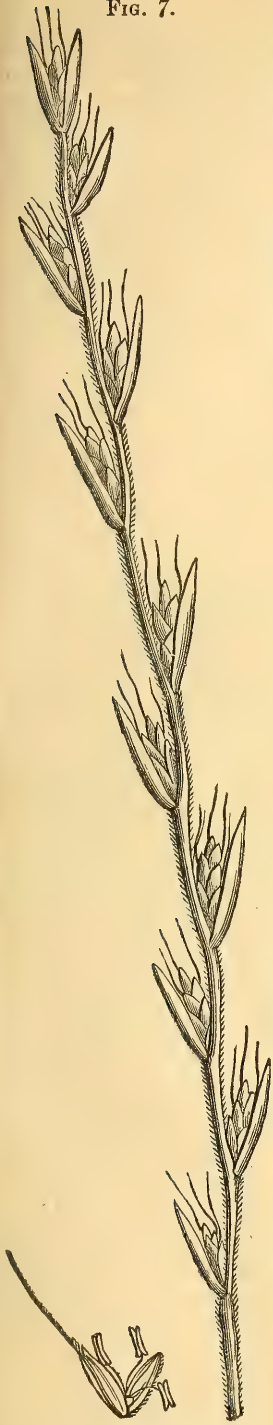
[t] *De Methodo Botanicâ, dubio et fallaci virtutum in plantis indice.* Ed. 2^{nda}. Lipsiæ, 1742.

Fig. 7.



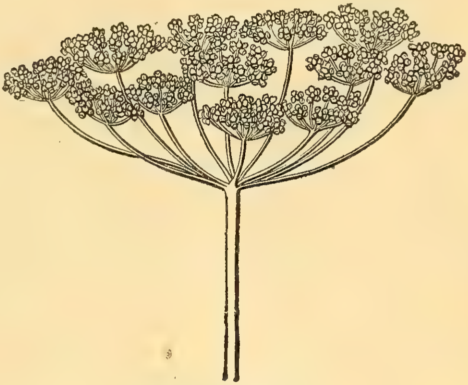
Lolium temulentum, or Bearded Darnel.

they possess stimulant properties. — Many other families might be quoted to the same effect; and, therefore, we admit, as a general rule, that plants, of similar structure, possess similar medicinal qualities.

The objections to this general rule are two-fold:—

1st. *Plants of the same Natural Order are frequently endowed with dissimilar Medical Properties.* The root and leaves of *Daucus Carota* are wholesome and nutritive, but the analogous parts of *Conium maculatum* are highly poisonous. Both of these plants, however, belong to the same natural order,—UMBELLIFERÆ (fig. 6). In some cases we find plants even of the same genus differing considerably in their medicinal properties; as *Cucumis Melo* and *Cucumis Colocynthis*, of the order CUCURBITACEÆ. If we are to believe the statements of credible writers, even GRAMINEÆ, which Decandolle declares to be "la famille la plus naturelle," contains more than one exception to the general statement in question. For the most part, the plants of this family are farinaceous and nutritive. "None," says Dr. Lindley[u], "are unwholesome in their natural state, with the single exception of *Lolium temulentum* (fig. 7), a common weed in many parts of England, the effects of which are undoubtedly deleterious, although perhaps much exaggerated." I may remark, however, that several other grasses have been asserted to be unwholesome. Loudon[v] tells us that the seeds of *Bromus mollis* bring on giddiness in the human species and quadrupeds, and are fatal to poultry. The

Fig. 6.



Fœniculum vulgare.
(UMBELLIFERÆ.)

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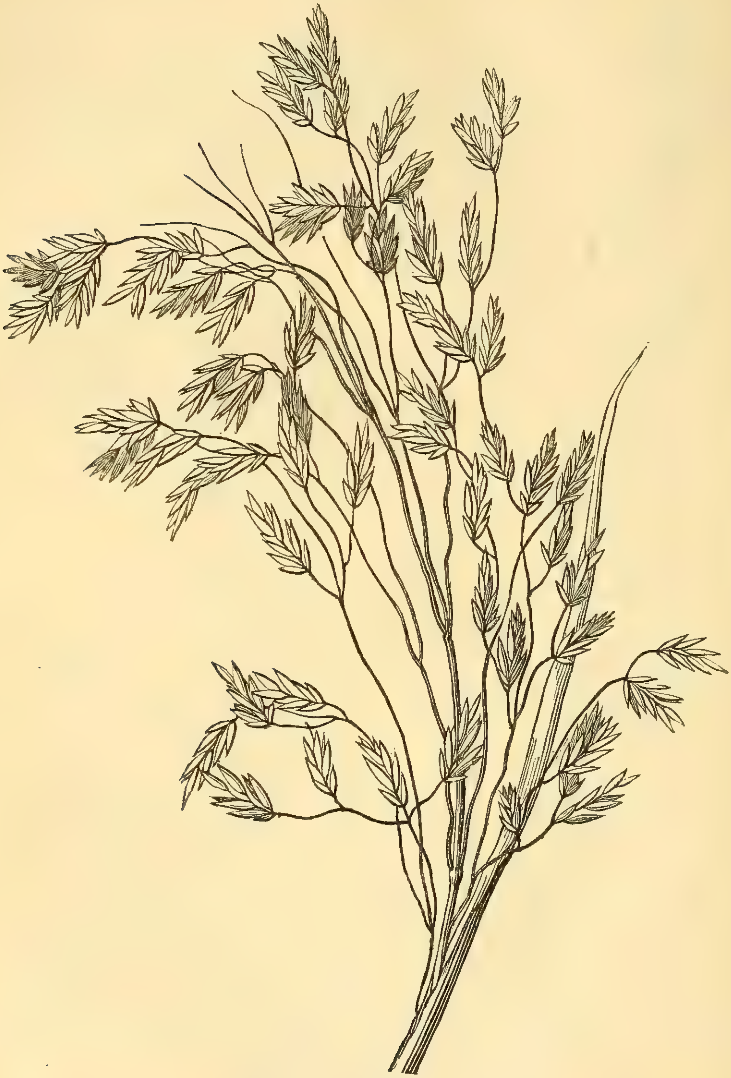
[u] *Natural System*, 2nd ed. 1836.
[v] *Encyclopædia of Plants*, p. 64.

root of *Bromus purgans* is said to be used in Canada as an emetic, in doses of forty grains. *Bromus catharticus*, a Chilian plant, has a thick root, which is stated to act as a purgative[w]. Humboldt[x] tells us that *Festuca quadridentata* (fig. 8) is very poisonous, and even fatal to animals. Perhaps this may be the grass described by some under the name of *Carapoucha*, and which by others has been called *Carapullo*. Frezier[y] says, in speaking of Lima, " There is an herb

Fig. 8.



Festuca quadridentata (Kunth).

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[w] *Dictionn. de Matière Médic. par F. V. Merat et A. J. De Lens*, tom. i. p. 672.

[x] *Voyage*, t. i.

[y] *Voyage to the South Sea and along the Coasts of Chili and Peru*, in the years 1712, 1713, and 1714.

called *Carapullo*, which grows like a tuft of grass, and yields an ear, the decoction of which makes such as drink it delirious for some days. The Indians make use of it to discover the natural disposition of their children. All the time when it has its operation, they place by them the tools of all such trades as they may follow,—as by a maiden, a spindle, wool, scissars, cloth, kitchen furniture, &c.; and by a youth, accoutrements for a horse, awls, hammers, &c.: and that tool they take most fancy to in their delirium, is a certain indication of the trade they are fittest for,—as I was assured by a French surgeon, who was an eye-witness of this verity." On this statement, Dr. Lindley[z] remarks, that it is uncertain whether the plant referred to be really of the order Gramineæ. "I cannot trace the name," he observes, "and the only Lima plant that I find bearing a name at all like it, is Physalis pubescens, which, according to the *Flora Peruviana*, is there called *Capuli*."

In the family SOLANEÆ we meet with other exceptions, as in the fruit of *Capsicum annuum* and *Atropa Belladonna*. I might select many other instances (especially from the family LEGUMINOSÆ) to the same effect, but shall content myself with the examples already adduced, as sufficiently warranting the assertion that, in the present state of science, botanical affinities cannot be *confidently* relied on by the medical practitioner for determining the effects of remedial agents. I cannot, therefore, agree with Dr. Lindley[zz], that "a knowledge of one plant is a guide to the practitioner, which enables him to substitute *with confidence* some other plant that is naturally allied to it." As a *general rule* we may admit, that plants of the same family agree in the *nature* of their medicinal operation, but to this statement there are many remarkable exceptions, which diminish, though they do not absolutely destroy, its utility in practice.

In some instances the exceptions are perhaps only apparent, and arise from our imperfect acquaintance with the affinities or structure of plants. We can readily imagine, that a slight and almost imperceptible difference in the structure of the nutritive organs of two plants, may be the cause of a trivial difference in the chemical composition of their products. Now organic analysis has shown us that a very inconsiderable difference in the combining proportions of the elements of organic substances is sometimes attended with important differences of medicinal activity.

2ndly. *Plants of dissimilar structure are sometimes endowed with similar or very analogous medical properties.* An oleo-resinous juice, called turpentine, is obtained from *Pistachia Terebinthus*, a plant of the order TEREBINTHACEÆ, and a substance possessing almost identical properties, and bearing the same name, is procured from the genera *Pinus*, *Larix*, and *Abies*, of the order CONIFERÆ Balsam of Copaiba, which agrees with the turpentines in all its leading properties, and whose constituents are actually isomeric with those of the turpentines, is procured from LEGUMINOSÆ. Yet the structure of Coniferæ is totally dissimilar to that of either Terebinthaceæ or Leguminosæ. Again, the effects of *Lobelia inflata*, a plant belonging to the order LOBELIACEÆ, are so analogous to those of *Nicotiana Tabacum*, which belongs to SOLANACEÆ, that the first-mentioned plant has received the name of Indian *Tobacco*. The term *Hellebore* (ἐλλέβορος) has been applied to two very different plants, viz. *Helleborus niger* and *Veratrum album*, in consequence, I presume, of an observed similarity of operation (both being drastic purgatives and narcotico-acrids); yet the first-mentioned plant is an exogen or dicotyledon, and belongs to the order RANUNCULACEÆ,—while the second is an endogen or monocotyledon, of the order MELANTHACEÆ.

c. *Of Animals.*—No attempts have been made to trace any relation between the toxicological, medical, or edible properties and the anatomical structure of animals. This has probably arisen from the comparatively small number of these beings which possess medicinal or poisonous properties; for we are enabled to employ, as food, animals of every class, from the highest to the lowest. Among Quadrupeds and Birds no species is poisonous[a], unless, indeed, the Arctic bear be an exception, whose liver is stated by Captain Scoresby[b] to be deleterious. Among Fishes, Mollusks, and Insects, however, several species are hurtful; and it is frequently found that where one is deleterious, kindred species are likewise more or less so. Thus all the coleopterous insects belonging to the tribe *Cantharidiæ* of Latreille possess blistering properties.

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[z] *Flora Medica*, p. 613. Lond. 1838.
[zz] *Natural System*, 2nd edit. p. viii.

3. The Chemical Properties of medicines have been sometimes resorted to for the purpose of determining the influence which these bodies have over the organism. For we sometimes find that substances possessed of similar chemical qualities operate in an analogous manner on the system. Thus Sulphuric, Nitric, and Hydrochloric acids, act very much alike; as do also Potash and Soda. But these analogies are not common, and we frequently meet with substances whose chemical properties are similar, but whose medicinal qualities are most incongruous, as in the case of Quina and Morphia: while, on the other hand, bodies whose chemical properties are exceedingly unlike, sometimes act in a very analogous manner; for example, Manna and Bitartrate of Potash.

The properties of bodies are so completely altered by chemical combination, that it is, in most cases, difficult to form a correct opinion as to the action of a compound medicine, merely by knowing the nature and proportion of its constituent parts. The compounds of some of the metals, however, offer exceptions to this statement.

Mr. Blake[c] contends that a very close relation exists between the chemical properties and physiological effects.

4. The Dynamical Properties. *Observation of the effects caused by the application of medicines to the animal body.*—Some have examined the action of medicines on *dead* animal tissues, and drawn inferences therefrom as to the operation on the living organism. This mode of proceeding was adopted by Dr. Adair Crawford[d]. But it is admissible only for those remedies whose action is either mechanical or chemical; and, therefore, with respect to the greater number of our remedial means, it is useless.

The examination of the effects of medicines on *living* animals is a much more valuable and important mode of investigation; for it may be asserted, as a general rule, that a substance which is poisonous to one species is more or less so to all classes of animals; and, in a considerable number of instances, its action is of the same nature or quality, though usually very different in degree, and modified by the variations in the development of the several organs and functions. It has indeed been stated that many substances which are poisonous to man are innocuous to animals, and *vice versâ*. That this statement is wholly untrue, I will not venture to affirm, but I think that it is an exaggerated one; and I believe, with Dr. Christison[e], that "if the subject be studied more deeply, the greater number of the alleged diversities will prove rather apparent than real."

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[a] Fleming's *Philosophy of Zoology*, vol. ii. p. 110. Edinb. 1822.

[b] *Account of the Arctic Regions*, vol. i. p. 520. Lond. 1820.

[c] *Proceedings of the Royal Society*, Jan. 28th, 1841.

[d] *An Experimental Inquiry into the Effects of Tonics and other Medicinal Substances.* Lond. 1816.

The animals employed for the purpose of ascertaining the operation of medicines are, ordinarily, the dog and the rabbit, and, occasionally, the cat and the horse. The dog and cat are supposed to be "affected by almost all poisons exactly in the same way as ourselves[f]."

The principal peculiarities which are observed in the operation of medicines in our domestic animals, may be conveniently arranged under three heads, as follow:—

a. Those relating to the nervous system.
b. Those connected with the structure of the digestive organs.
c. Those relating to the skin.

a. To the unequal development of the *Nervous System* of different animals, is to be referred the peculiarities observed in the operation of the substances termed Cerebro-spinants, or Narcotics, on different animals. Charvet[g], in noticing the effects of opium, observes that the brain of the dog being much less developed than that of man, "is not so liable to sanguineous congestion, and when this condition is observed, it is not very intense — stupor is the only symptom of it; never coma, loss of consciousness, nor profound sleep." I have observed that the root of Monkshood does not act precisely alike on rabbits and dogs. In the latter, one of the most remarkable symptoms of its operation is diminution of feeling; in the former, the function of feeling is much less obviously affected, but we observe more evident paralysis of the hind extremities and muscular weakness. Moiroud[h] says that "the smallest quantity of Nux Vomica is sufficient to poison the dog, while the goat eats with impunity Hemlock, and the hog, Henbane."

b. From differences in the structure of the *Digestive Organs* arise some peculiarities in the operation of medicines. In carnivorous animals, vomiting can be readily excited; whereas in herbivorous ones it is either not effected at all, or only with extreme difficulty, as in the horse and the rabbit. In the horse, the soft palate is so placed as almost to preclude the possibility of vomiting. "Whatever is returned from the stomach of the horse, passes through the nose[i].—As the rumen or paunch of ruminants possesses little sensibility and few blood-vessels, it is but slightly affected by medicinal agents. Hence in the administration of medicines to these animals, it is necessary to let them trickle slowly down so that they may flow along the œsophagean canal, and through the manyplies or third stomach, into the abomasum, or fourth or true stomach. Mr. Youatt[j] ascribes the occasional inertness of ergot of rye on the ruminant, to its being hastily poured from a large vessel, by which it falls into the paunch, and there remains inert.—Lastly, it is remarkable that colocynth, jalap, gamboge, and briony, which operate as violent purgatives on man and carnivorous animals, have comparatively little effect on the horse and other herbivorous animals[k].

c. The *skin* also presents some peculiarities in the operation of medicines. Thus dogs are but little under the influence of sudorifics: while the skin of horses is exceedingly susceptible of the action of oil of turpentine.

The action of medicines on the *dead* human body, or on parts separated from it (as the blood recently drawn from the veins), has been examined, with the view of learning the operation of these agents on the living body. It may be of assistance to us in ascertaining either the mechanical or chemical action of substances; but as the greater number of medicines act only on the living body, and quite independently of any known mechanical or chemical influences, this mode of investigation is of very limited value.

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[e] *Treatise on Poisons*, 3rd ed. p. 65.

[f] Christison, *op. supra cit.* p. 64.

[g] *De l'Action comparée de l'Opium*, p. 164. Paris 1826.

[h] *Pharmacologie-Vétérinaire*, p. 51. Paris 1831.

[i] Youatt, *The Horse*, p. 152. Lond. 1831.

See the article "*Ergot of Rye.*"

[k] Moiroud, *op. supra cit.* pp. 51, 269, and 274.

In ascertaining the action of remedial agents on the *living* body, it is necessary that we examine their influence both in healthy and diseased conditions. For, by the first we learn the positive or actual power of a medicine over the body; while by the second, we see how that power is modified by the presence of disease. Moreover, in the latter condition we sometimes discover remedial influences which our knowledge of the effects of medicines on the healthy body could not have lead us to anticipate. The beneficial operation of arsenious acid in agues, or in lepra, could never have been inferred from any experiments made with this substance in health merely; nor could we have formed a correct estimate of the effects and proper dose of opium by employing it in tetanus, nor by using mercurials in fever. The homœopathists assert, and with truth, that the study of the effects of medicines in the healthy state is the only way of ascertaining the *pure* or *pathogenetic* effects of medicines—since when we administer our remedies to invalids "the symptoms of the natural disease, then existing, mingling with those which the medicinal agents are capable of producing, the latter can rarely be distinguished with any clearness or precision[l]."

CHAPTER II.—OF THE ACTIVE FORCES OF MEDICINES.

The production of effects, by the application of medicines to the living body, depends on the existence of two classes of powers or forces; the one residing in the medicine (and called the *active forces of medicines*), the other in the organism.

Bodies act on each other in one or more of three ways; viz. *mechanically*, by their weight, cohesion, external form, and motion; *chemically*, by their mutual affinities; and *dynamically*, by agencies which are neither mechanical nor chemical merely. Hence we may examine the actions of medicines under the three heads of mechanical, chemical, and dynamical.

1. MECHANICAL.—The alterations of cohesion, of form, of relative position, &c. caused by medicines, are denominated their mechanical effects. They are frequently attended or followed by organic changes; consequently a medicine whose action is simply mechanical, may produce two classes of effects—the one mechanical, the other vital; and the whole of its operation may be denominated *mechanico-vital*.

Müller[m] considers that mechanical agents may give rise to chemical changes in the tissues. "Mechanical influence in frictions," he observes, "acts under certain circumstances, as a vivifying stimulus; it has this effect, probably, by inducing in the composition of the tissues, slight chemical changes, as a consequence of which the affinity of the tissues for the general vital stimuli already in the organism is increased."

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[l] Hahnemann's *Organon*, translated by C. H. Devrient, p. 190.

[m] *Elements of Physiology*, translated by Baly, p. 59.

Formerly most of the articles of the Materia Medica were supposed to act on the organism mechanically merely. "I doubt not," says Locke[n], "but if we could discover the figure, size, texture, and motion of the minute constituent parts of any two bodies, we should know, without trial, several of their operations one upon another, as we do now the properties of the square or a triangle. Did we know the mechanical affections of the particles of rhubarb, hemlock, opium, and a man, as a watchmaker does those of a watch, whereby it performs its operations, and of a file, which, by rubbing on them, will alter the figure of any of the wheels, we should be able to tell before-hand that rhubarb will purge, hemlock kill, and opium make a man sleep." These mechanical notions of Locke harmonized well with those of the *iatromechanical* or *iatromathematical* sect of the age in which he lived; a sect which ranked amongst its supporters Borelli (its founder), Bellini, and others, in Italy; Sauvages, in France; and Pitcairn, Keill, Mead, and Freind, in England. The functions of the body, the production of diseases, and the operation of medicines, were explained on mechanical principles. The action of stimulants, for example, was supposed to depend on the pointed and needle-like form of their particles, and the operation of emollients on their globular form[o]. I need hardly say, the existence of particles with the peculiar shapes assumed, is quite imaginary; and, indeed, if, for the sake of argument, we admit their existence, the action of medicines is, notwithstanding, quite inexplicable. We can, indeed, easily believe that a ball of glass may be swallowed with impunity, and that the same substance, reduced to the form of a coarse powder, might cause irritation by the mechanical action of the angular particles on the tender alimentary tube; but we could not, on this hypothesis, explain why one medicine acts on one part of the body, and a second on another part.

There are very few medicinal agents now in use whose remedial efficacy can be solely referred to their mechanical influence. Indeed, several of the processes to which medicines are subjected before they are administered, have for their principal object the prevention or diminution of this influence. Among the medicines still employed, on account of their mechanical action, are the hairs of the pods of *Mucuna pruriens*, quicksilver, and, perhaps, powdered tin; the first and the last are used as anthelmintics—the second, to overcome intus-susception, or intestinal invagination.

2. Chemical.—If substances, having powerful affinities for organic matter, be applied to the living tissues, they overcome the vitality of the part, and enter into combination with one or more of the constituents of the tissues: such substances are termed *caustics* or *escharotics*. But the destruction of life in one part is attended with alterations in the vital actions, and the production of inflammation in surrounding parts; so that the exertion of the affinities of caustics is attended by both chemical and vital effects, and the whole of the operation of these agents may be denominated a *chemico-vital process*.

If the energy of the affinity of caustics for organic matter be diminished, as by diluting them, the vital powers are sometimes enabled to resist the production of any immediate chemical change, and the life of the part is consequently preserved ; but its organic activity is disturbed and altered. This effect is termed *irritation*, and the agent inducing it is called an *irritant*. In this case the active force is still supposed to be affinity ; that is, the particles of the caustic are presumed to have a tendency to unite with those of the organised tissues; but the union being resisted by the vital powers, a new action is set up, which constitutes the changes or effects before referred to. The long-continued application, however, of weak chemical agents, will gradually effect slight changes in the composition of the tissues without producing the death of the altered parts. These organic alterations of a living part are of course attended by the production of morbid actions.

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[n] *Essay concerning Human Understanding*, book iv. chap. iii.

[o] Sprengel, *Hist. de Médec.* by Jourdan, t. v. p. 131, *et seq.*

Chemical changes are sometimes produced in the secretions of distant parts by the internal use of certain agents. Thus the qualities of the urine are modified by the administration of acids or alkalis. These modifications or changes depend, at least in a considerable number of instances, on the chemical influence of the substances swallowed. For when either alkalis or acids are swallowed, they pass out of the system, in part at least, by the kidneys ; and in the urine they possess their usual chemical properties, modified by the presence of any substances with which they may have united. Moreover, the qualities which they impress on the urine, are similar to those which they produce when added to this secretion after its evacuation from the bladder. Thus, by the internal use of alkalis, it has been found that the natural acidity of the urine may be destroyed, and an alkaline quality substituted for it: the same condition of urine is produced by the addition of alkalis to this fluid out of the body. Again, the internal use of soda or magnesia may give rise to the appearance of white sand (phosphates) in the urine: and the same kind of deposit is produced in healthy urine by the addition of a few drops of an alkaline solution to it. Furthermore, by the administration of acids (sulphuric or hydrochloric), phosphatic deposits are diminished or entirely prevented, while the employment of alkalis promotes them: and a few drops of hydrochloric acid added to urine, in which the earthy phosphates are suspended, dissolve them. In other words, as the modifications which acids and alkalis produce in the condition of the urine, are precisely those which we might expect from the known chemical properties of these bodies, it is rational to infer that they depend on the affinities of these substances.

Do substances (such as acids, alkalis, and metallic salts), which are known to possess affinities for the constituents of the blood and of the tissues, exercise those affinities in their passage through the system? and are the constitutional effects of those substances referrible to chemical influences? It is impossible to give satisfactory answers to either of these questions. We cannot deny the chemical influence of these agents ; but we are hardly authorised to ascribe the whole of their effects to it. The truth is, that the facts on which we are required to form our opinion are too few to enable us to draw any accurate or precise conclusions. By the internal use of madder, the bones and some other parts become coloured; and the long-continued employment of the nitrate of silver gives rise occasionally to a deposit of silver under the skin. But with two or three exceptions of this kind, no changes in the living tissues or organs have been demonstrated. We know that when external agents are taken into the system, they become subject to a superior power, and are no longer at full liberty to obey the ordinary laws of affinity. It must be some power superior to that recognized in chemical operations which prevents the action of the gastric juice on the stomach during life.

Müller[p], however, ascribes the operation of most external agents to their chemical influence. Vital stimuli, (a certain degree of external heat, atmospheric air, water, and nutriment), he observes, "do not merely produce a change in the composition of the organic structures, and stimulate by disturbing the balance in the system, but renovate the tissues by entering, in a manner indispensable to life, into their composition." On the other hand, all agents of this kind, as well medicinal substances, as caloric, electricity, and mechanical influences, "may, when their action is excessive, have the opposite of a vivifying effect, by producing such a violent change in the organic matter, that the combinations necessary to life cannot be maintained." "A great number of substances are important as medicaments, from producing a chemical change in the organic matter, of which the result is, not an immediate renovation of material and increase of vital force, but the removal of that state of combination of the elements which prevented healthy action, or excited diseased action; or the chemical change produced is such as to render the organ no longer sensible to a morbid stimulus; or it is such that certain apprehended destructive changes in its composition are no longer possible, as in the antiphlogistic plan of treatment; or, lastly, these substances produce a change in the nutritive fluids. Such substances are *alteratives*. By these remedies an organ morbidly changed in composition cannot be rendered sound by, as it were, a chemical process, but such a slight chemical change can be produced as shall render it possible for nature to restore the healthy constitution of the part by the process of nutrition. These remedies, again, may be divided into two principal kinds, according as they act chiefly on the nervous system, or on the other organs dependent on that system. Among those of the first kind, the most important are the so-called narcotics; those of the latter kind comprehend the numerous medicines which exercise their action on diseases in other organs. These remedies, also, by removing the obstacles to cure, become indirectly vivifying or renovating stimuli; and they may themselves, by disturbing the balance in a part, produce symptoms of irritation. If used to excess, they either give rise to the injurious effects of the heterogeneous stimulants, or, by inducing a sudden change of composition, annihilate the vital force, as is the case with the narcotics. Since, however, such alterative medicines affect the composition of an organ each in its own way, one alterative may, after a time, lose its influence, as it were, by saturation, while the organ may still be susceptible of the influence of another. A great number of the instances of habituation are referrible to this cause."

3. DYNAMICAL.—Some substances exercise a most potent influence over the organism, without producing any obviously mechanical or chemical changes in the organic tissues. Such substances are said to act *dynamically;* as hydrocyanic acid, morphia, strychnia, &c.

In the inorganic kingdom we have evidence of an influence which cannot be denominated either mechanical or chemical. The communication of magnetical and electrical properties to iron by mere contact with another body, without the production of any change of form or of composition, either of the iron itself or of the imparting body, is an example of this. Now, to influences of this kind the term *dynamical* has been applied; and several pharmacologists [q] have employed it to indicate those influences of medicines over the organism which are ascribable to neither mechanical nor chemical causes. As the term is a convenient one, I have adopted it.

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[p] *Elements of Physiology*, by Baly, vol. i. p. 58, et seq.

Some have attempted to account for the action of medicines on electrical principles. All bodies, says Bischoff [r], by contact with each other, act as electrics, without, however, necessarily undergoing any chemical changes. Therefore, when a medicine is applied to the organism, its action is electrical. But though, adds this writer, a medicine may produce electrical without chemical changes, yet the reverse of this does not hold good, for no chemical changes can occur without the production of alterations in the electrical condition of bodies; and, consequently, the operation of caustics is an electro-chemical process.

In some few instances the effects of medicines are analogous to those of electricity. Thus the instantaneous death caused by hydrocyanic acid is something like an electrical phenomenon. "A drop of acid, mixed with a few drops of alcohol," says Magendie [s], "when injected into the jugular vein, kills the animal instantly, as if he had been struck with lightning." The same physiologist has compared the convulsive shock, caused by the Upas Tieuté, "to that which takes place when a current of galvanic fluid is directed along the spinal marrow of an animal recently killed [t]." Again, "If an animal be touched whilst under the action of this substance [extract of nux vomica], it experiences a commotion similar to that of a strong electrical shock; and this takes place every time the contact is renewed [u]. The resent assertions of Prof. Zantedeschi and Dr. Favio (to which I have had already occasion to refer [v]), with respect to the existence of electric currents in the animal body, are especially interesting in connection with the above speculations. These experimentalists declare, that convulsive movements strengthen or exalt the neuro-electric current,—a statement which agrees with Magendie's remark as to the effect of nux vomica. Bischoff [w], however, denies the existence of electric currents in the nerves.

CHAPTER III.—ON THE PHYSIOLOGICAL EFFECTS OF MEDICINES.

The effects which medicines are capable of producing in healthy individuals, are denominated *Primary, Immediate*, or *Physiological*.

Formerly no distinction was made between the effects which medicines produce in health, and those which they give rise to in disease; and the terms *Virtues*, *Properties*, *Faculties*, and *Powers*, were applied to both classes of effects. But Bichat, and subsequently Barbier and Schwilgué, pointed out the propriety of considering them separately.

The Physiological Effects may, for convenience, be divided into such as are *local*, or which occur in the part to which the agent is applied; and those which are *remote*, or which take place in parts more or less distant from that to which the medicine is applied.

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[q] Burdach, *System der Arzneymittellehre*. Leipzig, 1807.—C. H. E. Bischoff, *Die Lehre von den chemischen Heilmitteln*. Bonn, 1825.—Vogt, *Lehrbuch der Pharmakodynamik*, 2td Aufl. Giessen, 1828.

[r] *Op. supra cit.* Bd. i. pp. 158, 162, and 163.

[s] *Formulaire*, 8me éd. p. 174. Paris, 1835.

[t] Orfila, *Toxicologie Générale*.

[u] *Formul.* p. 5.

[v] See pp. 34 & 35.

[w] *British and Foreign Medical Review* for July, 1841, p. 245.

1. *Local Effects.*

(Topical Effects.)

The local or topical effects of medicines are of three kinds,—*mechanical*, *chemical*, and *vital*.

1. Mechanical Effects.—The operation and primary effects of the hairs of *Mucuna pruriens*, and of demulcents, are mechanical. But mechanical effects are usually attended, or followed, by changes in the vital actions of the part; so that the total effect is *mechanico-vital*.

2. Chemical Effects.—A very large number of medicinal agents effect chemical changes in the parts to which they are applied.

The constituents of the tissues on which these agents expend the energy of their affinities, are principally water, albumen, fibrin, and gelatine. Water constitutes four-fifths of the weight of the animal tissues, and without it they are wholly insusceptible of vitality, except in the case of some of the lower animals[x]. Hence, therefore, agents like sulphuric acid, which powerfully attract water, act as caustics. Substances which either coagulate liquid albumen (as the mineral acids and alcohol), or which dissolve solid albumen, fibrin, and gelatine (as the alkalies), are also powerful caustics. Many salts (as bichloruret of mercury, sulphate of copper, acetate of lead, and chloruret of zinc), form new compounds when placed in contact with the organic principles just referred to: they are also called caustics. As a preliminary to the production of the chemical changes here mentioned, the caustic must destroy the life of the part. Lastly, around the cauterized parts inflammation is set up. So that the total effect of the chemical action of agents on the organism is *chemico-vital*.

Those medicines or agents, which produce a local chemical effect, admit of a three-fold division:—

a. Some produce the complete destruction of the parts with which they are placed in contact. *Oil of Vitriol*, *Nitric*, and *Hydrochloric Acids*, and the *Caustic Alkalies*, belong to this series. Liebig[y] refuses to call these substances poisons. They merely destroy, he says, the continuity of particular organs, and are comparable, in their operation, to a heated iron or a sharp knife.

b. Some enter into chemical combination with the tissues, or their organic components. To this series belong *Sulphate of Copper*, *Bichloride of Mercury*, *Acetate of Lead*, *Chloride of Zinc*, *Nitrate of Silver*, *Arsenious Acid*, *Tannic Acid*, &c. The components of the living part, when combined with any of these substances, are less susceptible of decay and decomposition than previously. Hence they are unfitted for the exercise of the "principal property which appertains to their vital condition; viz. that of suffering and effecting transformation:" in other words, their vitality is destroyed. In some cases the quantity of inorganic matter sufficient to destroy the life of a part, is very small; as in the case of arsenious acid and bichloride of mercury. Liebig[z] ascribes this to the high atomic weights of fibrine and albumen; and he states, that $3\frac{1}{10}$ grs. of arsenious acid, or 5 grs. of corrosive sublimate, are sufficient to form a neutral compound of equal equivalents with 100 grs. of fibrine, as it exists in muscle or blood; and that $1\frac{1}{4}$ grs. of arsenious acid are sufficient to unite with 100 grs. of albumen.

c. Some agents produce chemical effects distinct from those of the preceding two series. *The Salts, with an alkaline or earthy base*, and *Alcohol*, belong to this group. Liebig says, their action does not depend on their power of entering into combination with the component parts of the organism. Common salt and alcohol act by abstracting water from the moist tissues.

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[x] Müller, *Elem. of Physiol.* p. 7.

[y] *Organic Chemistry in its Application to Agriculture and Physiology.* Edited by Lyon Playfair, Ph. D. London, 1840.

[z] *Op. supra cit.* Liebig says, that 6361 parts of anhydrous fibrine are united with 30000 parts of water in muscular fibre or blood.

Liebig admits that some poisons act by catalysis. Thus, decomposing animal or vegetable matters are, he thinks, capable of inducing in the blood of a healthy individual a decomposition similar to that of which they themselves are the subjects. They exhibit, he says, a strong similarity to the action of yeast on liquids containing sugar and gluten. The poisons of small-pox, plague, and syphilis, act, he thinks, in this way. This view, which is a revival of an ancient opinion, is ingenious, but improbable.

3. VITAL EFFECTS.—The effects placed under this head are those which are unaccompanied by any obvious mechanical or chemical lesions.

Although it is probable, that no one component of a tissue can suffer much change in its vital activity without disturbing the actions of other components, yet we observe that the blood-vessels, the secretory apparatus, the organic fibres, and the nerves of a part, are affected, in unequal degrees, by different medicines.

a. In some cases the *blood-vessels* appear to be principally affected. Thus, Cantharides, Savine, Gamboge, Croton Oil, Mustard, &c. cause pain, heat, redness, and other symptoms of inflammation : these agents we denominate *irritants* or *acrids*.

b. In some instances the *secretory apparatus* is remarkably affected. Thus, Oxide of Zinc and Lime Water have a desiccating effect when applied to a secreting surface.

c. The effect of astringents and emollients is on the *organic fibres* chiefly.

d. The *nerves*, in some cases, are the parts principally affected. Thus, Aconite causes numbness, tingling, and a pricking sensation, with scarcely any visible alteration in the condition of the part.

2. *REMOTE EFFECTS.*

(General Effects).

NATURE OF THE EFFECTS.—In general the effects produced in parts more or less remote from the seat of application, are physiological or vital; that is, they consist of alterations of the vital actions. In some few instances, however, chemical changes are obvious.

a. VITAL EFFECTS.—Some substances, when taken into the stomach, influence the functions of remote organs, without our being able to detect, after death, any change in the structure or appearance of the parts whose functions are thus affected. Thus, Hydrocyanic Acid disturbs the cerebral functions,—and Foxglove acts as a diuretic, without inducing any visible topical alteration in the brain and kidneys respectively.

On the other hand, some agents give rise to visible changes in the condition of the parts acted on. Thus, Cantharides, in large doses, excites inflammation of the bladder,—Drastic Purgatives, of the rectum.

b. CHEMICAL EFFECTS.—The deposition of silver under the skin and in some internal organs, by the administration of the nitrate of that metal, and the red colour communicated to bones by the internal employment of Madder, are proofs that the solids remote from the seat of application may undergo slight chemical changes. Vogt[a], however, denies that any remote chemical effects can be induced. I have already[b] assigned reasons for believing that the alteration effected in the quality of the urine by the internal use of Acids and Alkalies, are the effects of a chemical influence.

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[a] Vogt, *Pharmakodynamik*, Bd. i. S. 15.

[b] See p. 102.

MEDIUM BY WHICH REMOTE EFFECTS ARE PRODUCED.—It has been hitherto generally supposed that there were two modes by which a medicine or poison affected remote parts: these were,—

1st. *By absorption*,—that is, by the passage of the medicinal or poisonous molecules into the blood.

2dly. *By sympathy*,—that is, by an impression transmitted through the nerves.

Sir Benjamin Brodie[c] inferred this double medium of operation from his experiments on several poisons. It has, however, always appeared somewhat improbable that an agent should be capable of affecting remote parts in two ways. "All fair analogy," observe Messrs. Morgan and Addison[d], "forbids the conclusion that a poison or an ordinary cause of disease shall at one time produce constitutional disturbance through the medium of one system of organs, and at another time through the medium of another system of organs." Difficulties, however, have hitherto appeared in the way of an exclusive adoption of either mode of operation; and, therefore, while Magendie, on the one hand, advocated the operation of absorption only, and Messrs. Morgan and Addison, on the other hand, that by sympathy only, most writers, dissatisfied with these exclusive views, have adopted Sir Benjamin Brodie's opinion of a double mode of operation. Although late investigations strongly favour, if, indeed, they do not absolutely establish, the correctness of Magendie's opinion, I think it expedient, so long as any doubt remains, to examine both theories; and, therefore, the two following chapters will be devoted to these subjects.

CHAPTER IV.—ON THE ABSORPTION OF MEDICINES.

PROOFS.—The particles of most medicinal substances, when applied to the living body, become absorbed and pass into the circulation. Two facts prove this, viz., the disappearance of certain substances from a shut cavity into which they had been introduced,—and the detection of medicinal particles in the blood, secretions, or solids of the body.

a. Disappearance from a shut cavity. — Drs. Christison and Coindet[e] found that four ounces of a solution of oxalic acid injected into the peritoneal sac of a cat, killed the animal in fourteen minutes. On a post-mortem examination, although none of the fluid had escaped by the wound, they found scarcely a drachm remaining.

b. Detection in other parts of the body.—Tiedemann and Gmelin[f] have detected, by physical or chemical characters, the following substances in the *blood* of animals to whom those agents had been administered: Camphor, Dippel's Oil, Musk, Indigo, Rhubarb, Lead, Cyanuret of Potassium, Sulphocyanuret of Potassium, Iron, Mercury, Baryta, and Alcohol. By other experimenters, Asafœtida, Sal Ammoniac, Iodine, Hydrocyanic, and Sulphocyanic acids, &c. have been found[g].

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[c] *Phil. Trans.* for 1811, p. 178; and for 1812, p. 205.

[d] *An Essay on the Operation of Poisonous Agents on the Living Body*, p. 14. Lond. 1829.

[e] *Edin. Med. and Surg. Journ.* xix. 335.

[f] *Versuche über d. Wege auf welchen Substanzen aus dem Magen u. Darmkanal ins Blut gelangen.* Heidelberg, 1820.

[g] For authorities consult Magendie's *Elementary Compendium of Physiology*, and Christison's *Treatise on Poisons*.

In the *solids* of the body several substances have been recognized: for example, Madder in the bones, Silver in the skin, Copper in the liver, Lead in the liver, spinal cord, and muscles, Mercury in various parts, &c.

In the *secretions* various medicinal agents have been recognized.—Thus, *in the cutaneous secretions*, Mercury, Iodine, Sulphur, the odorous matter of Musk, of Garlic, and of Onions, and other substances, have been detected;—*in the breath*, several substances have been recognized by their odour; for example, Camphor, Alcohol, Ether, Phosphorus, Asafœtida, Sulphur, the odorous matter of Garlic, and of Onions, &c. The *milk* sometimes acquires medicinal properties, in consequence of the employment of certain substances by the nurse. Thus it is rendered purgative by Senna, and narcotic by Opium. "Alkalies given to the nurse will relieve acidity in the child's stomach; and Mercury given through a similar medium will cure syphilitic symptoms in the infant at the breast[h]." Bitters, Indigo, Iodine, and Madder, have also been distinctly recognized in the milk. *In the urine* so many substances have been discovered, that it will be most convenient to exhibit them in a tabular form. The following is taken principally from the experiments of Drs. Wöhler and Stehberger, as mentioned by the late Dr. Duncan[i].

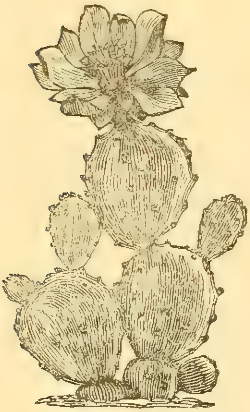
SUBSTANCES WHICH PASS OFF BY THE URINE.

(A.) UNCHANGED, OR NEARLY SO.

Salts.

Carbonate of potash.
Nitrate of potash.
Chlorate of potash.
Sulpho-cyanide of potassium.
Sulphuret of potassium.
Ferro-cyanide of potassium (in 66 minutes.)
Silicate of potash.
Tartrate of nickel and potash.
Borax.
Chloruret of barium.

FIG. 9.



Cactus opuntia;
Small Indian or Prickly Fig.

Colouring Principles.

Indigo
Madder } (in 15 minutes).
Rhubarb (in 20 minutes.)
Gamboge.
Logwood (in 25 minutes).
Turmeric (Lewis).
Red radishes.
Mulberry.
Black cherry (in 45 minutes).
Cassia Fistula (in 55 minutes.)
Elder rob (in 75 minutes).
Cactus Opuntia (see fig. 9).

Odorous Principles
somewhat altered.

Oil of turpentine.
——— juniper.
Valerian.
Saffron.
Asafœtida.
Garlic.
Castoreum.
Opium.
Narcotic principle of Amanita muscaria.
Asparagus (*Cullen*).

Other Matters.

Astringency of Uva ursi (45 minutes.)
Oil of almonds (*Bachetoni.*)

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[h] Dr. Locock, in *The Cyclop. of Pract. Medicine*, art. *Lactation*. The same authority states that a patient of Mr. Keate took Mercury by giving the Nitrate of this metal to an ass, and drinking the milk.

[i] *Supplement to Edinburgh Dispensatory*, 1829.

(B.) IN A STATE OF COMBINATION.

Sulphur, as sulphuric acid and sulphuretted hydrogen.
Iodine, as hydriodic acid or ioduret.
Oxalic
Tartaric
Gallic (in 20 minutes) } Acids, appear in combination.
Succinic
Benzoic

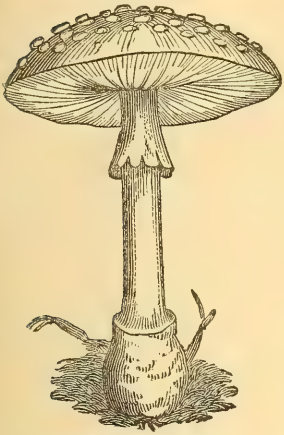
(C.) IN A DECOMPOSED STATE.

Tartrate
Citrate } of potash, or soda, are changed into the carbonate of the same alkali.
Malate
Acetate

Sulphuret of potassium, changed, in a great measure, into the sulphate of potash.

If the accounts published respecting the *Amanita muscaria* (fig. 10) be correct, its effects are most extraordinary. A variety of this fungus has a powerful narcotic or rather inebriating effect; and that the active molecules get into the blood is proved by the fact of the urinary secretion being impregnated with them, and thus possessing an intoxicating property; and we are told that the inhabitants of the north-eastern parts of Asia use it for this property. A man, for example, may have intoxicated himself to-day by eating some of the fungus; by the next morning he will have slept himself sober; but by drinking a tea-cupful of his urine, he will become as powerfully intoxicated as on the preceding day. "Thus," says Dr. Greville, on the authority of Dr. Langsdorf, "with a very few *Amanitæ*, a party of drunkards may keep up their debauch for a week;" and "by means of a second person taking the urine of the first, a third of the second, and so on, the intoxication may be propagated through five individuals[j]."

FIG. 10.



Amanita muscaria.

VESSELS EFFECTING ABSORPTION.—The particles of medicinal and poisonous substances are absorbed by the veins principally, but also by the lymphatics and lacteals.

1. *ABSORPTION BY THE VEINS.*—The circumstances which seem to prove venous absorption are the following:—

a. Detection of substances in the venous blood.—Tiedemann and Gmelin[k] administered a variety of colouring, odorous, and saline substances to animals, mixed with their food, and afterwards examined the state of the chyle, and of the blood of the (splenic, mesenteric, and portal) veins. The *colouring* substances employed were—Indigo, Madder, Rhubarb, Cochineal, Litmus, Alkanet, Gamboge, and Sap-green; none of them could be detected in the chyle, but some were found in the blood and urine. The *odorous* substances used were—Camphor, Musk, Spirits of Wine, Oil of Turpentine, Dippel's Oil, Asafœtida, and Garlic: they were, for the most part, detected in the blood and urine, but none were found in the chyle. The *saline* substances tried were—Acetate of Lead, Acetate and Cyanuret of Mercury, Chloruret and Sulphate of Iron, Chloruret of Barium, and Ferro-cyanide and Sulpho-cyanide of Potassium. A few of these were detected in the chyle, and most of them in the venous blood and urine. From these experiments we may conclude, that although saline substances occasionally pass into the chyle, odorous and colouring matters do not; all the three classes of substances, however, are found in the venous blood. These results, observe Tiedemann and Gmelin, are opposed to those of Lister, Musgrave, J. Hunter, Haller, Viridet, and Mattei, but agree with those of Hallé, Dumas, Magendie, and Flandrin.

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[j] See also, on this subject, *The History of Kamtschatka and the Kurilski Islands*, translated by Dr. J. Grieve, p. 208. Gloucester, 1764.
[k] *Op. supra cit.*

b. Division of all Parts but Blood-vessels.—Magendie's Experiment.—Magendie and Delille[l] performed a striking experiment, with the view of settling, if possible, the question of venous or lymphatic absorption of medicines and poisons. They divided all the parts of one of the posterior extremities of a dog, except the artery and vein, the former being left entire, for the purpose of preserving the life of the limb. A portion of the *Upas Tieuté* was then applied to a wound in the foot: in the short space of four minutes the effects of the poison were evident, and in ten minutes death took place. To the inferences drawn from this experiment, however, several objections have been stated: first, the exhibition of opium, to diminish the pain of the operation, has been said to vitiate the whole of the experiment; secondly, the coats of the arteries and veins contain lymphatics, by which absorption might be carried on; and thirdly, as the poison was introduced into a wound, the poison might have combined with the blood, and have rendered it deleterious, without the process of absorption taking place. The first two of these objections have been obviated. In a second experiment, Magendie severed the artery and the vein, and reconnected them by quills, so as to preclude the possibility of absorption taking place by the lymphatics of these vessels: the effects were the same. Some years since I assisted my friend Mr. Lloyd, assistant-surgeon of St. Bartholomew's Hospital, in performing an analogous experiment, using *Strychnia* instead of the *Upas Tieuté*, and without administering opium: death took place in twelve minutes.

The late Dr. Thomas Davies[m] observes, on this experiment, that as the absorbents and veins communicate, it is possible that the poison flowed first into the absorbents, and from thence into the veins of the amputated portion of the limb.

c. Lacteals tied: effects of poisons still produced.—Magendie says that symptoms of poisoning were observed in six minutes, when nux vomica was applied to the intestine, though the lacteals had been tied.

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[l] Magendie's *Elementary Compend. of Physiology,* translated by Dr. Milligan, p. 284. Edin. 1823.
[m] *Lectures on the Diseases of the Lungs and Heart,* p. 213. Lond. 1835.

d. Blood-vessels tied: poisons do not act.—Segalas tied the veins of a portion of intestine, and applied poison, but no effects were produced. Emmert observed, that when the abdominal aorta was tied, hydrocyanic acid was applied to the foot without producing any effect, but when the ligature was removed, symptoms of poisoning came on[n]. Mr. Blake[o] found, that if a ligature be put around the vena portæ, and then poison be introduced into the stomach, it failed to act.

It deserves notice, that the Academy of Medicine of Philadelphia found that nux vomica, introduced into the intestines, produced tetanus, although the vena portæ was tied[p].

e. Rapidity of absorption and circulation too great for the lymphatics or lacteals.—Mayer[q] found that Ferro-cyanide of Potassium could be detected in the blood, in from two to five minutes after its injection into the lungs. From this it has been inferred that it enters the blood too speedily for it to be explained by the slow circulation of the lymph. From later experiments, it appears that the rapidity with which poisons enter the blood has been greatly underrated. Professor Hering, of Stuttgardt[r], found that the time which a solution of Ferro-cyanide of Potassium, injected into the jugular vein, requires to reach that of the opposite side, was, in various experiments, from twenty to thirty seconds. And Mr. Blake[s] states that the time required for a substance which does not act on the capillary tissue, to pass from any part of the vascular system back to the same part again, in dogs, varies from twelve to twenty seconds.

Rapid as is the circulation of poisonous molecules, it has been supposed not to be sufficiently so to explain the operation of certain poisons which have been said to act instantaneously; and hence an argument has been raised in favour of the nerves being the medium by which the deadly impression is conveyed. But Mr. Blake[t] asserts that an interval, always more than nine seconds, elapses between the introduction of a poison into the capillaries or veins, and the first symptom of its action;—a period sufficiently long for a poison to be brought into general contact with the tissues it affects.

2. *Absorption by the lacteals and lymphatics.*—The particles of medicinal and poisonous substances are probably absorbed by the lacteal and lymphatic vessels, as well as by the veins. But the process seems to be slow, and, moreover, is confined to certain agents. Tiedemann and Gmelin, whose experiments I have above referred to, were unable to recognize either colouring or odorous substances in the chyle, but occasionally detected certain salts. The absorption of saline, and non-absorption of colouring matters, have likewise been noticed by others[u].

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[n] Müller's *Elements of Physiology*, by Baly, vol. i. p. 242.

[o] *Edinb. Med. and Surg. Journ*, vol. liii. p. 45.

[p] Müller, *op. supra cit.* vol. i. p. 240.

[q] Müller's *Physiology*, by Baley, vol. i. p. 239.

[r] Quoted by Dr. Christison, in his *Treatise on Poisons*, p. 8, 3d ed. 1835.

[s] *Edin. Med. and Surg. Journ.* vol. liii. p. 42.

[t] Ibid. p. 49.

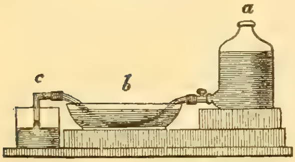
[u] Müller's *Physiology*.

Some of the experiments performed by the Academy of Medicine, at Philadelphia, appear to be in favour of absorption being effected chiefly by the lymphatics: but they are not conclusive.

MECHANISM OF ABSORPTION.—The facts connected with absorption are best explained by assuming the existence of two powers or agencies by which this process is effected;—the one physical, and the other vital.

1. *Absorption by physical agency* (*Imbibition*, Magendie; *Exosmose* and *Endosmose*, Dutrochet.)—Two fluids separated by an interposed dead membrane, mutually, though not equally, permeate the membrane, so as to become intermixed with each other.

FIG. 11.



Apparatus to illustrate Physical Absorption.

If a current of water, coloured by litmus, be allowed to pass from a bottle (fig. 11), through a vein immersed in diluted sulphuric acid, contained in a glass dish (*b*), into a reservoir (*c*), the litmus liquor is soon observed to become reddened by its passage through the vein, in consequence of the acid permeating the venous coats. If the relative position of the fluids be altered,—that is, the litmus put in the dish (*b*), and the acid passed from the bottle (*a*) through the vein, the litmus will still become reddened, shewing that the acid has passed in this case from within outwards.

Gases and vapours, as well as liquids, also readily permeate dead animal membrane. But the same membrane is unequally permeated by different gases.

But it may be said this effect is cadaveric only; that is, it occurs in the dead, but not in the living, tissues:—and in support of this view may be urged, the transudation of blood within the blood-vessels, and of bile within the gall-bladder, both of which phenomena are observed after death. Magendie has endeavoured to meet this difficulty with respect to the imbibition of poisons. He exposed and isolated the jugular vein of a dog, placed it on a card, and dropped some aqueous solution of the extract of nux vomica on its surface, taking care that the poison touched nothing but the vein and the card. In four minutes the effects of the substance became manifest, and the dog died[v]. It must be admitted, however, that the result of this experiment does not absolutely prove, though it strongly supports, the opinion, of the imbibing power of the living vessels; for it might be objected, that the nerves of the venous coats propagated the impression of the poison, and that death took place without absorption; or, that the small veins of the venous coat had taken up the poison. The proof, therefore, should consist in the detection of the poison within the vessel. Now this has been obtained by Magendie: a solution of nux vomica was placed on the carotid artery of a rabbit; but as the tissue of arteries is firmer and less spongy, and their parietes thicker than those of veins, a longer time elapsed before the poison traversed the vessel. In fifteen minutes, however, it had passed, and on dividing the vessel the blood adherent to its inner wall was found to possess the bitter taste of the poison.

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[v] Magendie, *Lectures*, in the *Lancet*, Oct. 4, 1834.

With these results before us, we cannot refuse to admit the imbibition of living tissues, though in them this process cannot be effected so readily as in dead tissues.

2. *Absorption by a vital agency.*—The physical and chemical agencies, with which we are at present acquainted, are totally inadequate to explain all the phenomena of absorption; as the interstitial absorption of solid matter,—for example, in the bones. We are constrained, therefore, to admit another agency, which we may denominate vital or organic.

ABSORPTION OF A MEDICINE, OR POISON, ESSENTIAL TO THE PRODUCTION OF ITS REMOTE EFFECTS.—Magendie and Müller[w] consider the passage of poisons into the circulation essential to their operation on the system: while Messrs. Morgan and Addison[x] deny that in any case absorption is absolutely necessary for the operation of a poison. "We are not opposed," observe the latter gentlemen, "to the theory of venous absorption, but to that theory which would associate with it the *absolute necessity* for the admission of a poison into a vein." The following facts appear to me to prove, that absorption is essential to the production of the remote effects:—

1. *Activity of Substances injected into the Blood-vessels.*—Medicinal or poisonous agents, injected into the blood-vessels, exert the same kind of specific influence over the functions of certain organs, as when they are administered in the usual way; but that influence is more potent. Thus, Tartar Emetic causes vomiting, Castor Oil purging, Opium stupor, and Strychnia convulsions, when thrown into the veins.

2. *Detection of Substances in the Blood.*—All those medicinal and poisonous agents, whose sensible or chemical properties enable them to be readily recognised, have been detected in the blood, or in the secretions which are formed from the blood, after their ordinary modes of administration; as by the stomach.

3. *Activity of Medicines promoted by the means which promote absorption, and vice versâ.*—The remote effects of many medicinal and poisonous agents are influenced by the same circumstances that influence absorption; and we are, therefore, naturally led to presume a mutual relation. Now, these circumstances are principally three in number, viz. the nature of the tissue to which the agent is applied—the properties (physical or chemical) of the medicine itself—and the condition of the system.

a. Nature of the tissue.—Nux vomica acts with the greatest energy when applied to the pulmonary surface,—with less when introduced into the stomach,—and with the least of all, when applied to the skin. The same order of gradation is observed with respect to opium. Now, the faculty of absorption, or of imbibition, as Magendie calls it, does not take place with equal intensity in all tissues. Certain physical conditions (viz. a fine and delicate structure and great vascularity) enable the pulmonary surface to absorb or imbibe with extreme rapidity: in this respect, indeed, it is not equalled by any tissue of the body. Hence, then, if we assume that nux vomica and opium act by becoming absorbed, we can easily comprehend why they are so energetic when applied to this part. The membrane lining the alimentary canal absorbs with less facility than the pulmonary membrane, which may be accounted for by its less vascularity, and by its being covered, in some parts at least, by an epidermoid layer, and in all its parts by mucus, which, to a certain extent, checks absorption. The cutaneous surface, lastly, being covered by an inorganic membrane (the epidermis) does not possess the same physical faculties for absorption met with in either of the foregoing tissues; and hence the comparative inertness of medicines when applied to it. In fact, it is only by the long-continued application of these agents to the skin, that we are enabled to affect the general system; and that the obstructing cause is the epidermis, is shewn by the facility with which the system may be influenced when this layer is removed, as has been proposed and practised by Lembert and Lesieur, constituting what has been denominated the *endermic* or *emplastro-endermic* method of treating diseases; of which method I shall have occasion to speak hereafter.

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[w] *Physiol.* p. 246, et seq.

[x] *Essay on the Operation of Poisonous Agents.* Lond. 1829.

b. The physical and chemical properties of medicines.—Another circumstance, tending to prove some connection between the activity of a medicine and its absorption is, that the effect of many medicines is in proportion to their solubility. Arsenious Acid and Morphia are both more energetic in solution than in the solid state. Now liquids (particularly those miscible with the blood) are much more readily absorbed than solids. In the treatment of many cases of poisoning, we endeavour to take advantage of this fact, and by rendering substances insoluble, diminish their activity, or render them quite inert. Thus the antidote for the salts of Lead, and of Baryta, is a Sulphate, the acid of which forms an insoluble compound with the bases (Lead or Baryta) of these salts. Tannic acid (or astringent infusions which contain it) is for the same reason found useful in cases of poisoning by vegetable substances whose active principle is an alkaloid; and we employ Carbonate of Lime as an antidote for Oxalic acid, to render this substance incapable of being absorbed.

c. Condition of system.—Magendie asserts, as the result of experiments, that plethora uniformly retards, and depletion as constantly promotes, absorption. If, therefore, we wish to promote this function, we have a ready means of doing so in blood-letting. Now every surgeon knows that one powerful means of promoting the action of mercurials on the mouth, is to abstract blood; and, therefore, we should be cautious in bleeding a patient, while a poisonous dose of some narcotic, as opium, is in the stomach. Nay, in theory, the best means of preventing the operation of poisons which act by becoming absorbed, would be to throw a quantity of warm water into the veins. Magendie tried this on animals, and found it successful.

4. *Division of all parts but blood-vessels. Magendie's experiment.*—The experiment of Magendie, already related[y], of applying the *Upas Tieuté* to the leg of a dog, connected to the body only by two quills, is another argument in favour of the operation of medicines by absorption: for in this case the action of the poison could have taken place only after it had passed into the blood.

5. *Division of the spinal cord.*—Some poisons, as Hydrocyanic acid, are equally active when applied to the legs of an animal whose spinal marrow has been divided. In this case, the effect of the poison could not be the result of its action on the nerves of sensation and voluntary motion. But it may be said the division of the lumbar spine does not prevent the action of poisons by the nervous system, because it does not destroy the action of the excito-motory or sympathetic systems, the nervous branches of which are distributed to the lining membrane of the blood-vessels. I am aware that it is an experiment liable to objection; but, on the whole,

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[y] See p. 110.

it is certainly favourable to the opinion of the operation of poisons by absorption; more particularly when we bear in mind that the motion of the blood is necessary to the action of the poison; for if the circulation of a part be obstructed, the poison will no longer act.

6. *Ligature on the veins.*—If the veins leading from a poisoned part be tied, the symptoms of poisoning do not occur[z].

These reasons are, to my mind, conclusive, that in a large number of instances at least, if not in all, the operation of a medicine on remote parts of the system depends on its absorption. Nor can I admit that this opinion is at all invalidated by the arguments and experiments of Messrs. Morgan and Addison.

Other arguments in favour of the view here taken, may be derived from some experiments made by Mr. Blake[a], of which a short notice only has as yet appeared. Mr. Blake states that the rapidity of the action of a poison, is in proportion to the rapidity of the circulation. Thus, he says, a substance injected into the jugular vein of a horse, arrives at the capillary termination of the coronary arteries in ten seconds; of a dog, in twelve seconds; of a fowl, in six seconds; of a rabbit, in four seconds; and he adds, that the time required for the first symptoms of the poison to present themselves, bears a close relation to the rapidity of the circulation.

The principal objections, which have been raised to the theory of the operation of medicines by absorption, are the following:—

1. Absorption not essential.—The experiments of Magendie and others, it has been observed, only show that a poison may get into the veins, and do not prove that absorption is essential to the effect. "We must strongly protest," say Messrs. Morgan and Addison, "against the assumption that, because a poison has been found to enter and pass through a vein, it is thence to be inferred that such a process is, under all circumstances, absolutely necessary to its operation." But it has been proved that the more absorption is facilitated the more energetic do poisons act, and *vice versâ*.

2. The Effects of Injuries and Poisons analogous.—Mr. Travers[b] points out very forcibly the analogy to be observed between the effects of severe injuries and of poisons which operate rapidly on the system. Thus both strychnia and punctured wounds cause tetanus, and he, therefore, concludes their *modus operandi* must be identical: consequently, as there is nothing to absorb in the one case, so absorption cannot be essential in the other. But although the symptoms caused by the above poison are very analogous to those of traumatic tetanus, yet we are not to conclude that the effects of strychnia and of a puncture are precisely alike. We have abundant evidence to prove, that very dissimilar conditions of the nervous centres may be attended with similar symptoms. Phrenitis and delirium tremens resemble each other in symptoms, yet experience has shown that they are very dissimilar diseases, and require different methods of treatment. A morbid state of the cerebral faculties, strongly resembling that induced by congestion, may be produced by loss of blood. "The fact of two substances producing similar symptoms in one organ," observes Müller[c], "does not prove that these substances produce exactly the same effects, but merely that they act on the same organ, while the essential actions of the two may be very different." And I confess I see nothing unphilosophical in supposing that the same morbid condition of the part may be induced in more than one way: for as every part of the organism depends, for the performance of its proper functions, on the receipt of arterial blood and of nervous influence, so alterations in the supply of either of these essentials may modify or even suspend the functions of a part.

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[z] See p. 111.

[a] *Lond. Med. Gaz.* for June 18th, 1841.

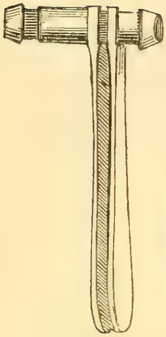
[b] *Further Inquiry concerning Constitutional Irritation.*

[c] *Op. cit.* p. 56.

3. **Blood of a poisoned Animal declared not to be poisonous.**—Messrs. Morgan and Addison tell us that the blood circulating in the carotid artery of a dog, poisoned by strychnia, is not poisonous to a second dog, and they therefore infer that this poison does not act on the brain by absorption, but by an impression upon the sentient extremities of the nerves.

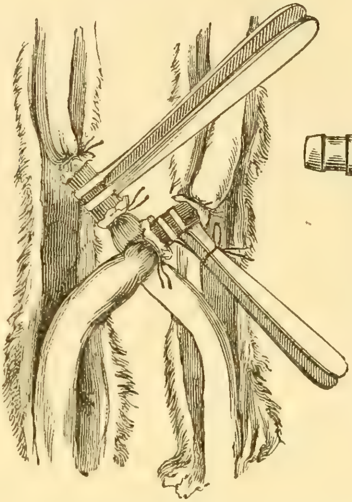
By the aid of a double brass tube (fig. 12), consisting of two short brass cylindrical tubes, to each of which a long handle is attached (fig. 14), they established a complete circulation between the carotids of a poisoned and of a sound dog, by connecting the lower and upper ends of the divided arteries in both animals, so that each supplied the brain of the other with the portion of blood which had previously passed through the carotid artery to his own, and, consequently, the poisoned dog in this case received from the unpoisoned animal a supply of arterial blood equal to that with which he was parting (Fig. 13). One of the dogs was then inoculated with a concentrated preparation of strychnia, which had been found upon other occasions to produce death in these animals in about three minutes and a half. In three minutes and a half the inoculated animal exhibited the usual tetanic symptoms which result from the action of this poison, and died in little less than four minutes afterwards, viz. about seven minutes from the time at which the poison was inserted, during the whole of which period a free and mutual interchange of blood between the two was clearly indicated by the strong pulsation of the denuded vessels throughout their whole course. The arteries were next secured by ligature, and the living was separated from the dead animal; but neither during the operation, nor subsequently, did the survivor shew the slightest symptom of the action of the poison upon the system.

Fig. 12.



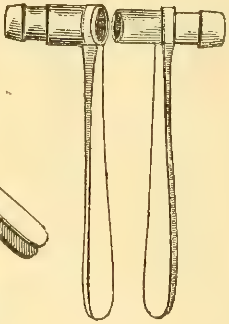
Double Brass tube.

Fig. 13.



Double circulation between the Carotids of a poisoned and a sound dog.

Fig. 14.



Single cylindrical Brass tubes.

The inference which has been drawn from this experiment is, that the arterial blood of an animal under the influence of poison is not poisonous. But it appears to me that this is not a necessary inference, and as it is opposed to the result of other experiments, it requires careful investigation ere we admit it. Vernière[d] has proved that if the extract of nux vomica " be thrust into the paw of an animal after a ligature has been tightened round the leg, so as to stop the venous, but not the arterial circulation of the limb, blood drawn from an orifice in a vein between the wound and ligature, and transfused into the vein of another animal, will excite in the latter the usual effects of the poison, so as even to cause death; while, on the contrary, the animal from which the blood has been taken will not be affected at all, if a sufficient quantity is withdrawn before the removal of the ligature."

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[d] Christison, *Treatise on Poisons*, 3d ed. p. 10.

Mr. Travers[e], in noticing the different results obtained by Vernière and Messrs. Morgan and Addison, observes, that "if it be inquired why the poisoned blood concentrated below a ligature, and transferred into the vein of a healthy animal, proves destructive, while the blood of their common circulation affects only the one of the two animals which is the subject of the inoculation, the answer is obvious—that either the mechanical impulse fails, or the activity of the poison is exhausted before, in the latter case, it reaches the second animal."

A remarkable error pervades the whole train of reasoning adopted by Messrs. Morgan and Addison, and vitiates some of their conclusions. They assume that Magendie considers actual contact with the brain as essential for the operation of the Upas poison[f]. This assumption, however, is not correct. "In 1809," says Magendie[g], "I laid before the first class of the French Institute, a series of experiments which had conducted me to an unexpected result; namely, that an entire family of plants (the bitter Strychnos) have the singular property of powerfully exciting the spinal marrow, without involving, except indirectly, the functions of the brain." Now, this being Magendie's opinion, it is evident that, in the experiment performed by Messrs. Morgan and Addison, the blood sent from the carotid artery of the poisoned animal to the brain of the sound one, could only reach the spinal marrow by the usual route of the circulation; that is, it must be returned by the jugular veins to the heart, from thence to the lungs, back again to the heart; from thence into the aorta, and then distributed through the system. Now it is not too much to suppose that, during this transit, some portion of the poison might be decomposed, or thrown out of the system, before it could arrive at the spinal marrow: and even if this were not the case, this organ could only receive a small quantity of the poison contained in the system; namely, that sent by the vertebral to the spinal arteries. Hence we ought to expect that a poison thrown into the arteries will operate less powerfully than when thrown into the veins, unless it be into the arteries supplying the parts on which the poison acts. Moreover, as an anonymous reviewer [Sir David Barry?] has observed[h], it is to be recollected, that as the carotid artery, in its healthy state, is little more than one-fourth of the calibre of the vessels carrying blood directly to the brain, consequently the dog not inoculated was subject to the influence of one-fourth only of the quantity of the poison which was conveyed to the *brain alone* of the inoculated animal. Furthermore, I would add, that it is not too much to suppose that the circulation of the blood through the tube would not be so free as through the artery. Another objection to this experiment has been raised by Mr. Blake[i], who asserts, that as "soon as the poison begins to exert its influence on either animal, the pressure in its arterial system will be diminished; and thus, far from the blood containing the poison being sent to the brain of the sound animal, the only effect of the arrangement will be to cause a reflux of pure blood from the arteries of the sound dog into those of the poisoned one."

HOW DO MEDICINES AND POISONS, WHICH HAVE ENTERED THE BLOOD-VESSELS, AFFECT DISTANT ORGANS?—Viewing the question theoretically, we can conceive three ways, by one or more of which remote parts might become affected after medicinal globules have passed into the blood.

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[e] *Op. cit.*
[f] See pp. 42, 43, 47, 49, &c. of the *Essay.*
[g] *Formulaire,* 8me éd. p. 1.
[h] *Lond. Med. and Phys. Journ.* vol. lxiii.
[i] *Edinb. Med. and Surg. Journ.* vol. liii. p. 48.

1. *By modifying or altering the properties of the blood, and thereby unfitting it for carrying on the functions of the body.*—Although no facts are known which can be regarded as absolutely proving that the action of medicines or poisons is primarily on the blood, yet none I believe are inconsistent with such a notion in all cases, while several strongly favour it: and it has been justly observed by Andral[j], that "as the blood nourishes the solids, and as without its presence they cannot support life, the state of the solids cannot but be influenced by the state of the blood."

In the first place, it must be admitted that in many diseases the properties of the blood are altered, and in some cases these alterations often appear to be primary; that is, they precede alterations of the solids.—Secondly, in some diseases the blood acquires poisonous properties, and is capable of transmitting the affection of the individual from whom it was taken.—Thirdly, by the use of poisons, medicines, and particular kinds of diet, the properties of the blood become altered, while at the same time the condition of the solids is modified. Now as from the food is formed the chyle, from the chyle the blood, and from the blood the solids, a necessary connection must exist between the quality of the ingesta and the condition of the solids. For facts and arguments relative to these positions, I must refer to Andral's work before quoted.

But if medicines or poisons introduced into the torrent of the circulation act primarily on the blood, what, it may be asked, are the effects produced?

In some cases the action is mechanical, as when air is introduced into a vein. "A very small quantity of air," says Magendie[k], "passed slowly into a vein, mixes with the blood, traverses the lungs, and is exhaled with the pulmonary transpiration, without causing any remarkable accident; but when the quantity is increased, especially in a sudden manner, the air mixes with the blood contained in the heart, and forms with it a foamy kind of liquid, which does not pass readily through the capillary system of the pulmonary artery. In consequence of this obstacle to the passage of the blood through the lungs, the respiration and circulation become necessarily troubled, and the animal soon dies in a state of asphyxia,—not from any pernicious action of the air on the nervous system[l]." Water, when introduced into the circulation, probably acts merely as a diluent. For though when mixed with blood out of the body it causes a change in the condition of the red blood disks, we can hardly suspect that it produces a similar effect within the blood-vessels, from the circumstance that large quantities of water may be thrown into the veins without causing any remarkable disorder of system; whereas, if the disks were altered, great disorder of the system might be expected. Solutions of various substances (as sal ammoniac, chloruret of sodium, carbonate of potash, sugar, &c.) produce no obvious change in the disks out of the body.

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[j] *Treatise on Pathological Anatomy*, translated by Drs. Townsend and West, vol. i. p. 642.

[k] *Lancet*, Nov. 15, 1834.

[l] For further information *On the Influence of Air in the Organs of Circulation*, see Dr. J. R. Cormack's *Prize Thesis* on this subject. Edin. 1837.

Some substances exercise a chemical action on the blood; as the mineral acids, the alkalis, various metallic salts, alcohol, &c. The affinity of these agents is principally directed to the fibrin and albumen of the liquor sanguinis, and to the constituents of the blood disks. Hydrocyanic acid even would appear to be a chemical agent, since it makes the blood oily, fluid, and bluish in colour. Such substances, therefore, as exercise a chemical influence, cause speedy death when they are thrown into the veins, unless, indeed, the quantity introduced be very small. It is possible that organic substances may, as Dr. Christison supposes, be decomposed in the blood, without that fluid undergoing any apparent change. "A very striking proof of this is furnished by oxalic acid. Dr. Coindet and I, in one of our experiments, injected into the femoral vein of a dog eight grains and a half of oxalic acid, which caused death in thirty seconds. Here it was impossible that the poison could have passed off by any of the excretions; yet we could not detect even that large proportion in the blood of the iliac vein and vena cava, collected immediately after death. As the blood possessed all its usual properties, we must suppose that the poison underwent decomposition in consequence of a vital process carried on within the vessels[m]." Liebig[n] has suggested another mode by which medicinal agents may effect chemical changes in the condition of the blood. It is well known that the acetate of potash is converted, during its passage through the system, into carbonate of potash. Now, to undergo this alteration, it must absorb oxygen, and set carbonic acid and water free; and as there is no evidence that the system yields oxygen, Liebig assumes that the change takes place in the lungs. So far his opinion seems plausible. But he goes on to observe that this change in the lungs would prevent part of the oxygen inspired from performing its usual office: in other words, the arterialization of the blood would be impaired. This part of the explanation seems to me improbable.

We can readily believe that slight chemical changes may be affected in the blood disks, without our being able to demonstrate them: yet these changes may be sufficient to produce great disorder of system.

It must not, however, be assumed, that agents which effect chemical changes in the blood out of the body, or when injected into the veins, necessarily produce the same phenomena when absorbed from the intestinal or other surfaces; for the quantity taken up at any one time by this process is small in proportion to the volume of the circulating fluid, and the affinities between these agents and the constituents of the blood seem to be kept in check by the vital properties. Moreover, the affinities of these substances for organic matter are more or less satisfied in the alimentary tube.

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[m] *Treatise on Poisons*, 3d. ed. p. 16.

[n] *Organic Chemistry*.

As the blood is a vital fluid, medicines may effect changes in it which are neither mechanical nor chemical. Strychnia and morphia produce no obvious effect on the blood, yet it is not impossible that they may cause some changes in its vital condition; and that to these, part of the symptoms, caused by their use, are to be referred. Here, however, all our remarks are but conjectural.

2. *By pervading the structure of the organ acted on.*—The usual mode of explaining the action of medicines after their absorption, is, that when they have got into the blood, they are carried in the ordinary course of circulation to the heart, and from thence to the lungs. Here the blood undergoes certain chemical changes, and is probably deprived of part of the medicinal particles: at least this appears to be the case with respect to certain odorous substances. The blood, still impregnated with medicinal particles, being returned to the heart, is transmitted from thence to all parts of the system. In their passage through the tissues of the different organs, it is presumed that these particles act on one or more parts which are endowed with a peculiar susceptibility to their influence. Thus the opiate particles are supposed to exert a specific influence on the cerebral tissues; strychnia is thought to act on the grey matter of the spinal marrow; mercury, on the salivary glands; diuretics, on the kidneys; and so on. Müller supposes that a change is effected on the composition of the organic matter of the part acted on. The molecules are ultimately got rid of by the excretory organs. On this supposition, then, the blood is merely the "vehicle of introduction."

It must be admitted that this theory, plausible as it may appear, cannot be satisfactorily proved. We may adduce several arguments in favour of it, but absolute proof or demonstration cannot be offered: our facts merely show the passage of medicinal particles into the blood, and the affection of remote organs; but the link which connects the two phenomena cannot be, or at least has not yet been, demonstrated. The strongest argument in favour of this mode of explanation is, that the molecules of certain medicines may be detected in some one or more of the excreted fluids; while, at the same time, the functions of the organs secreting or excreting these fluids, have become influenced by the medicine. Now the simplest, and therefore the most plausible explanation is, that the molecules, in passing through the organ, acted on its tissue, and thus gave rise to a functional change. The diuretic effects of nitre, alkalis, turpentine, &c., are readily explained on this theory. Even when the affected part is not a secreting organ, medicines have, in a few cases, been recognized in the organs on which they act. Thus alcohol and ether have been detected in the brain by their smell. But when the medicinal agent is not readily detected by its physical or chemical properties, we have not the same evidence to offer in support of this view, which, notwithstanding, may be not the less true.

Several objections present themselves to this explanation. Many medicinal substances may be detected in the secretion of an organ, though no evident influence has been exercised over the organ itself. Thus the colouring particles of rhubarb may be recognised in the urine, although the action of the kidneys does not appear to be altered ; and, therefore, it may be said, that in those cases where the quality of the secretion is affected, we have no right to infer that it depends on the passage of medicinal particles through the secreting vessels. But we know the susceptibility of the same part is not the same to all medicines; for it is not every medicine which, when applied to the stomach, produces vomiting.

It has also been said that this theory of medicines "being conveyed by the circulation to different parts, is utterly gratuitous, and no less improbable." "What intelligence," says an American writer[°], "directs them in this voyage of circumnavigation to the port of destination; and how, on their arrival (admitting it to happen), are they separated from the great mass of fluids in which they are enveloped?" It is not supposed, on this theory, that medicines are *conveyed to particular parts*, but *to every part* of the body in which the blood circulates. How then, it may be replied, is it that particular parts only are affected, since medicinal molecules are in contact with every part? We do not pretend to account for this circumstance. Every one is familiar with the fact that carbonic acid may be applied to the stomach in large quantity with impunity; whereas, if taken into the lungs, it acts as a narcotic poison. The urine has very little effect on the bladder, but if introduced into the cellular tissue, gives rise to violent inflammation.

I have already (p. 115) alluded to another objection to this theory—namely, that injuries sometimes produce the same symptoms as poisons. But it must be recollected that, in a large number of instances, injuries do not produce the same symptoms; and in those cases where the effects of the two are analogous, I see no difficulty in assuming that there are two modes of affecting the nervous system. Moreover, we know that two different conditions of the brain may present the same symptoms.

The most important objections that have been advanced against the operation of medicines through the circulation, by local contact with the tissues, are those founded on the experiments of Messrs. Morgan and Addison. Of all their experiments, the following are, I conceive, the strongest against the theory under examination:—

The jugular vein of a full-grown dog was secured by two temporary ligatures; one of which was tied round the upper, and the other round the lower part of the exposed vein. The vessel was then divided between these two ligatures, and the truncated extremities re-connected by means of a short brass cylinder or tube (fig. 16), within which was placed a portion of woorara, of the size of a grain of canary-seed (fig. 15). Both the temporary ligatures were then removed (fig. 17), the accustomed circulation through the vessels was re-established, and in forty-five minutes the animal dropped on the ground, completely deprived of all power over the

Fig. 15.

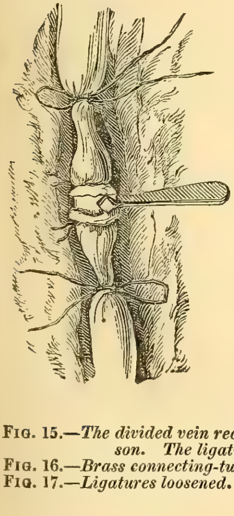


Fig. 16.

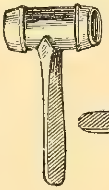


Fig. 17.

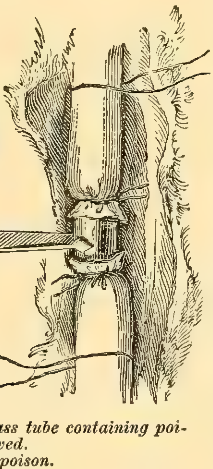


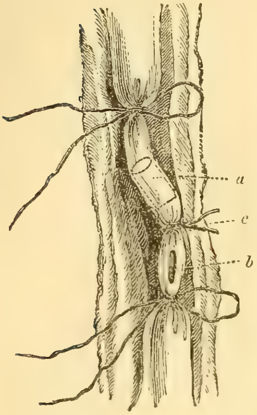
Fig. 15.—*The divided vein reconnected by a brass tube containing poison. The ligatures not yet removed.*
Fig. 16.—*Brass connecting-tube containing the poison.*
Fig. 17.—*Ligatures loosened.*

[°] Chapman, *Elements of Therapeutics*, 4th ed. vol. i. p. 73.

muscles of voluntary motion: in two minutes, convulsions and respiration had entirely ceased. This result was to be expected, whatever theory be adopted.

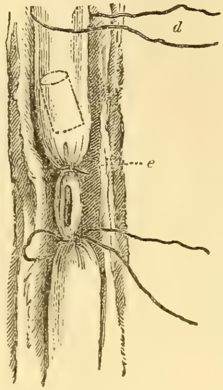
In another experiment two temporary ligatures were applied to the jugular vein, as in the former case. A cylinder of quill, containing a little woorara, was then introduced into the vein between the two ligatures; another ligature was then applied (fig. 18), and the upper temporary ligature removed (fig. 19). In the space of 108 seconds after the removal of the ligature, the animal dropped in convulsions, as in the former case, and expired in 3¼ minutes. Now, in this experiment, the direct entrance of the poisoned blood into the heart, &c. was prevented by the lower ligature; hence, if the poison operated by contact with the brain, a greater length of time was necessary for its effects to be produced; inasmuch as the circulation was no longer going on through the trunk of the jugular itself, and, therefore, if the poison acted by actual contact, it must have got into the system by the vessels of the vein.

Fig. 18.



a. *Cylinder of quill containing poison introduced into the vein by the aperture,* b*; the ligature,* c, *being afterwards applied. The ligature,* d, *not yet removed.*

Fig. 19.



Ligature, d, *unloosened;* c, *remaining.*

This experiment, however, cannot be regarded as conclusive. For although the "result is certainly different from what might have been anticipated, on the supposition of the circulation of the poison in the blood being essential to its action, yet we cannot regard it as a conclusion against that supposition, unless it were shown that the poison, when the ligature above it is removed, and when it mingles itself with the stream of blood in the vein, does not taint this blood as far back as the next anastomosing branches, and so make its way forward to the heart. That this is not the effect of removing the farther ligature is not shown by these authors; and their other experiments in favour of their peculiar doctrine of the mode of action of poisons, we have no difficulty in pronouncing to be inconclusive[p]." Moreover, the poison may act by diffusion.

3. *By acting on the lining membrane of the blood-vessels.*—Messrs. Morgan and Addison contend, that when poisons are "introduced into the current of the circulation in any way, their effects result from the impression made upon the sensible structure of the blood-vessels, and not from their direct application to the brain itself[q]." The proofs adduced in support of this theory, are, first, "the extreme susceptibility of the inner coat of a vein, when exposed to the action of a poison," as shown by the experiment related above; secondly, that woorara acts on the brain as quickly when injected into the femoral, as when thrown into the carotid, artery; thirdly, that woorara, applied to the cut surface of the cerebrum, caused no

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[p] See a criticism in *The British and Foreign Medical Review,* vol. v. for Jan. 1837.

[q] *Essay,* p. 60.

symptoms of poisoning; fourthly, that by establishing a complete double circulation between the carotids of a poisoned and of a sound dog, the latter does not become affected.

Of all these "proofs," however, the only important, though not unobjectionable one, is the first. The validity of the second objection has been denied by Mr. Blake (see page 125). The second and third are merely negative; their object being to show that poisons do not act by pervading the structure of the part: and to the fourth I have before offered some objections.

In conclusion, then, I would observe, that while Messrs. Morgan and Addison have thrown some doubt over our previously received notions on the operation of medicines, it cannot be admitted that they have established their own hypothesis; and further experiments are still required to settle this doubtful question.

In a recent discussion on the operation of poisons, at the Royal Medical and Chirurgical Society [r], Dr. Addison admitted that "the researches of Mr. Blake and others, had rendered the balance in some measure favourable to the theory of absorption."

CHAPTER V.—ON THE OPERATION OF MEDICINES BY NERVOUS AGENCY.

Messrs. Morgan and Addison contend, "that all poisons, and perhaps, indeed, all agents, influence the brain and general system, through an impression made upon the sentient extremities of the nerves, and not by absorption and direct application to the brain."

The circumstances which have been adduced in favour of this view, are—

1. The rapid action of some poisons.
2. The effects being disproportionate to the facility for absorption.
3. The effects of several poisons being analogous to those of severe injuries.
4. The rapidity of action not being diminished by increasing the distance of the brain from the part of the vascular system into which the poison is introduced.

1. *The rapid operation of some poisons.*—One drop of pure hydrocyanic acid, says Magendie, placed in the throat of the most vigorous dog, causes it to fall dead after two or three hurried inspirations. Sir Benjamin Brodie once happened to touch his tongue with the end of a glass rod which had been dipped in the essential oil of bitter almonds; scarcely had he done so, before he felt an uneasy, indescribable sensation at the pit of the stomach, great feebleness of limbs, and loss of power to direct the muscles, so that he could hardly keep himself from falling. These sensations were quite momentary. In the cases now quoted, the rapid action of the poisons seems almost incompatible with the idea of their absorption. Dr. Christison [s] says, that two grains of conia, neutralized with thirty drops of diluted muriatic acid, being injected into the femoral vein

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[r] *Lond. Med. Gazette,* June 18, 1841.

[s] *Transactions of the Royal Society of Edinburgh,* vol. xiii

of a young dog, stopped respiration, and with it all external signs of life, in two seconds, or three at farthest.

In this case the death appears to have been too speedy to admit of the supposition that the effect occurred in consequence of the direct contact of the poison with the brain or spinal marrow.

Mr. Blake[t] has met this argument by declaring that poisons are not instantaneous in their action, but that sufficient time always elapses between the application of a poison and the first symptom of its action, to admit of its contact with the tissue which it affects. Thus he found, that after half a drachm of concentrated hydrocyanic acid had been poured on the tongue, eleven seconds elapsed before any morbid symptom appeared, and death did not occur until thirty-three seconds after the exhibition of the poison; and on repeating Dr. Christison's experiment, he found that fifteen seconds elapsed after ten drops of conia (saturated with hydrochloric acid) had been injected into the femoral vein of a dog, before symptoms of the action of the poison appeared; and death did not occur until thirty seconds after the injection. Now the time required for a substance to be absorbed by the capillaries, and diffused through the body, may not exceed, according to Mr. Blake, nine seconds. So that the interval which elapsed in the preceding experiments, between the application and the effect, is quite sufficient to admit of the absorption and circulation of the poison.

2. *The effects being disproportionate to the facility for absorption.*—Orfila[u] says, that alcohol acts with much less energy when injected into the cellular texture, than when taken into the stomach; and, as the power of absorption is greater in the former than in the latter part, he concludes that the remote action of alcohol must, in the first instance, be produced by the agency of the nerves. Opium, on the contrary, is supposed to operate by absorption, because it is more active when injected into the cellular texture than when taken into the stomach.

This experiment requires repetition. Even if the result be as stated by Orfila, the inference drawn from it is by no means a necessary one. As alcohol coagulates the blood when mixed with this fluid, its absorption would be more active in the dilute than in the concentrated state. Now, the secretions and contents of the stomach may, by diluting the alcohol, promote its absorption.

3. *The effects of some poisons being analogous to those of severe injuries.*—Thus, a tetanic state is produced by Strychnia as well as by a punctured wound.

As tetanus can be produced without the absorption of any thing (as when it arises from the laceration of a nerve), it is not necessary, it has been urged, to suppose this process in the case of strychnia. Mr. Blake[v] has endeavoured to meet this objection by suggesting that, in the first case, the disease may arise from the propagation of some pathological state from the injured nerve to the nervous centres; for were the symptoms the mere result of the local irritation of a nerve, we might expect, he observes, to produce them at pleasure, by merely irritating the nerve; but it is well known, he adds, that this is not the case. The latter part of this statement is not quite correct; for Dr. Marshall Hall[w] says, that "if one of the lateral nerves [of the decapitated turtle] be laid bare, and pinched continuously, the muscles of the upper extremities, as well as the lower, are forcibly contracted. This is, in my opinion, the very type of tetanus."

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[t] *Edinb. Med. and Surg. Journ.* vol. liii. p. 35.
[u] *Toxicologie Générale.*
[v] *Edinb. Med. and Surg. Journ.* vol. liii. p. 37.
[w] *On the Diseases and Derangements of the Nervous System,* p. 333. Lond. 1841.

4. *The rapidity of action not being diminished, by increasing the distance of the brain from the part of the vascular system into which the poison is introduced.*—Messrs. Morgan and Addison found, that the woorara poison produced its effects, when thrown into the femoral artery, a few seconds sooner, than when introduced into the carotid artery. Now, if contact with the brain were necessary to the action of this poison, a longer time would be required in the former than in the latter case for the production of any morbid symptoms.

Mr. Blake, however, asserts that in his experiments he found, that the nearer to the nervous centres is the part of the vascular system into which the poison is introduced, the more rapid is its action.

CHAPTER VI.—OF THE PARTS AFFECTED BY THE REMOTE ACTION OF MEDICINES.

The remote effects of medicines consist of alterations in the blood or in the functions of one or more organs more or less distant from the parts to which these agents were applied. Although an alteration of function presupposes an organic change, yet the latter is not always obvious.

A medicine may affect a distant organ directly or indirectly. The stupor caused by Opium is presumed to arise from the direct influence exercised by this drug over the cerebrum, since it cannot be otherwise accounted for. The convulsions produced by Strychnia, on the other hand, depend on the influence which this agent exercises over the true-spinal or excito-motory system, and to its direct action on the muscles.

Some medicinal agents and poisons confine their direct remote influence principally to one organ, and indirectly disorder the functions of other organs, through the relations which exist between the affected organ and other parts of the body. Strychnia is an example of this kind. In some cases, however, poisons appear to exercise a direct influence over several remote parts. Arsenic and Mercury are agents of this kind.

The intimate relations which exist between the different organs and functions, make it exceedingly difficult, and, in many cases, even impossible, to distinguish between the direct and the indirect influence of a medicine. In the following examples, of parts and functions affected by medicines, this distinction has not been attempted.

1. THE BLOOD.—We can readily believe that some agents may affect the whole system by altering the qualities of the blood. I have already[x] adduced several reasons for believing, that changes are induced in the condition of the circulating fluid by some medicinal substances. If this be admitted, we can then readily understand how these agents affect the general system. " In fact, when all the

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[x] See p. 118.

tissues thus receive a vitiated blood, is it not consistent with sound physiology to admit, that their regular modes of vitality, nutrition, and secretion, must be more or less deeply modified? We must either admit this conclusion, or deny the influence which, according to every physiologist, the blood exerts over each solid. It may, then, happen that one or more organs are affected in a more decided manner than the rest, and there may thus be produced in them various lesions that are only accidental and secondary: but it is not in these lesions the origin of the affection lay; it is not on them all the symptoms depend; nor, lastly, is it to them alone we are to have recourse, to throw a light upon the true nature of the disease, as well as upon the treatment proper to be pursued[y]."

It is probable that Mercury, the Alkalis, and many other agents, affect the quality of the blood.

2. CEREBRAL AND TRUE SPINAL SYSTEMS[z].—Substances which promote sleep, as Opium, or prevent it, as Green Tea; or which disorder the mental faculties, as Alcohol; or which impair sensibility[a], as Belladonna and Aconite, act on the cerebral system. Those agents which cause convulsions, as Strychnia; or paralysis, as Conia, affect the true spinal system.

3. MUSCULAR SYSTEM.—If the tone and irritability of the muscular fibre be, as it probably is, a direct function of the true spinal system, agents which affect these properties should properly be classed in the preceding division. At present, however, it is convenient to consider them under a separate head. Opium, Alcohol, Conia, and many other agents, diminish the irritability of the muscular fibre; while Strychnia and Brucia increase it. The substances denominated Tonics, increase the firmness and elasticity of muscles.

4. CIRCULATORY SYSTEM.—The action of the organs concerned in the circulation of the blood is affected by medicines, principally through the agency of the nervous system. Foxglove and Tobacco diminish the force of the circulation; while Alcohol, used in moderation, augments the volume and frequency of the pulse. Lead has a constringing effect on the blood-vessels. The temperature of the body is raised by agents which excite the circulation, and, *vice versâ*, it is reduced by those which lower the action of the vascular system. Diluted Acids and the Neutral Salts of the Alkalis appear to check preternatural heat, and they are, in consequence, denominated Refrigerants. Some other agents, probably, affect the calorific function by influencing respiration.

5. RESPIRATORY SYSTEM.—The action of the muscles of respiration is affected by those agents, already referred to, which either augment or lessen the irritability of the muscular system generally. Laennec[b] supposed, and probably with truth, that some cerebro-spinants (*e. g.* Belladonna and Stramonium) diminish the necessity of

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[y] Andral, *Pathol. Anat.* by Drs. Townsend and West, vol. i. p. 663.

[z] These terms are used in the sense assigned to them by Dr. Marshall Hall, (see his work *On the Diseases and Derangement of the Nervous System.* Lond. 1841).

[a] Belladonna causes dimness of sight; Aconite is a topical benumber of the nerves of touch.

[b] *A Treatise on the Diseases of the Chest,* translated by Dr. J. Forbes, pp. 77 & 99. Lond. 1827.

respiration. It is not improbable that certain medicines may, by their presence in the blood, retard or promote the process of respiration (*i. e.* the changes which the blood suffers in the lungs). Liebig has suggested that the vegetable salts of the Alkalis (as the Acetate of Potash) do this, as I have already explained[c]. The sensibility of the membrane lining the aerian passages is diminished by Opium and some other cerebro-spinants. The preparations of Lead, as well as Opium, check the secretions of this part;—while some substances, denominated Expectorants, appear at times to promote it. In diseases of this membrane we sometimes find the vital actions of the part modified by agents (such as Ipecacuanha and Senega) which, although they are usually denominated expectorants, do not always produce any evident increase in the secretions of the bronchial membrane. Emetic Tartar and Corrosive Sublimate, when used in poisonous doses, occasion an inflammatory condition of the pulmonary tissue.

6. DIGESTIVE SYSTEM.—The sensibility and the secretions of the gastro-intestinal membrane are diminished by Opium. Mercury, on the other hand, promotes the secretions of this part. It especially affects the salivary glands and the mouth, causing salivation; and, when used in large quantities, ulceration and sloughing. Belladonna and Stramonium (as well as Hyoscyamus) produce dryness of the fauces; and, when given in poisonous doses, diminish or even destroy the power of deglutition. Many substances, denominated Emetics, occasion vomiting: some of these, as Mustard, do so by their acridity; others, as Ipecacuanha and Emetic Tartar, by a specific influence over the stomach. The digestive process is readily affected by medicines. Opium checks it, and allays hunger; Condiments and the Bitter Tonics, under some circumstances, promote the appetite and digestion. In some disordered conditions of the stomach we have several medicines which often exercise a remarkably beneficial influence. Thus, Hydrocyanic Acid, Creosote, Trisnitrate of Bismuth, Magnesia, Calumba, and Effervescing Liquors, frequently allay vomiting and stomach pain. Purging is effected by the substances denominated Cathartics; and constipation by Opium. Mercury increases the secretion of the liver (and of the pancreas ?)

7. URINARY SYSTEM.—The sensibility of the organs composing this system is diminished by Opium, and its alkali Morphia, which cause relaxation, and, in extreme cases, paralysis of the muscular fibres of the bladder and ureters. Strychnia increases the irritability of the muscular fibres of the bladder. Cantharides occasions irritation, and, in large doses, inflammation of the bladder. Several Volatile Oils (as those of Copaiba, Turpentine, Cubebs, &c.) affect the mucous membrane of the urethra and bladder, and relieve, or cure, blennorrhagia of these parts. Uva Ursi, Buchu, and Pareira brava, evince a controlling influence over some morbid conditions of the vesical mucous membrane. The Tincture of the Sesquichloride of

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[c] See p. 119.

Iron sometimes relieves spasmodic stricture of the urethra. Drastic purgatives, especially those acting on the lower part of the bowels, irritate the urinary organs, especially the bladder. The secretion of the kidneys is augmented by certain substances, denominated Diuretics, and is lessened, in diabetes, by Opium. The Alkalis, Acids, certain Neutral Salts, Oil of Turpentine, &c. modify the quality of the urine.

8. Sexual System.—Ergot of Rye excites contractions of the uterus, by which matters contained in the cavity of this viscus are expelled. Savine operates as a stimulant to the blood-vessels and excretory apparatus of the uterus, and thereby acts as an emmenagogue. Opium dulls the sensibility of the sexual organs. Phosphorus and Cantharides have long been regarded as venereal excitants. Strychnia is said to possess a similar power.

9. Secreting and Exhaling Organs.—Mercury, the Alkalis, and Iodine, augment the activity of the secreting and exhaling organs. The Oleo-Resins, and the Balsams, stimulate the mucous surfaces. Opium diminishes the mucous secretions. Diuretics promote the secretion of urine—Diaphoretics the cutaneous exhalation—Sialogogues the saliva and buccal mucus—Emmenagogues the catamenia—Expectorants the bronchial secretion, &c.

CHAPTER VII.—OF THE GENERAL NATURE OF THE EFFECTS OF MEDICINES.

The vital actions of the system may be either changed or annihilated by medicines and poisons. The changes may be *quantitative* or *qualitative*. Agents which merely augment or lessen vital activity, effect quantitative changes, and are termed, respectively, *stimulants* and *sedatives;* while those which alter the nature of vital action occasion qualitative changes, and are the true *alteratives*. Agents which destroy the essential composition of an organized tissue, destroy or annihilate vital action.

1. Stimulants.—These agents are of two kinds: *general vital stimuli*, and *special stimuli*[d].

α. General Vital Stimuli.—These are agents whose constant operation is essential to the maintenance of life. They are caloric, water, atmospheric air, and nutriment. They support life by effecting constant changes in the composition of the organized body.

β. Special Stimuli.—These agencies vivify or strengthen only under certain conditions. They "produce this effect by restoring the composition of the organ by their ponderable or imponderable influence, or by so changing its composition that the renovation by the general vital stimuli is facilitated. All this, however, depends on the state of the diseased organ; and the cases in which the so-called stimulant and tonic remedies have really their supposed effect, are very rare." Special stimuli may be arranged in three groups, according as their principal action is on the nervous system, the circulatory system, or the gastro-enteritic organs.

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[d] Müller's *Physiology*, by Baly, vol. i. p. 59.

1. *Nervous Stimuli*, e. g. Alcohol.
2. *Cardiaco-vascular Stimuli*, e. g. Ammonia.
3. *Gastro-enteritic Stimuli.* e. g. Spices.

2. SEDATIVES.—These are agents whose action is the reverse of that of stimulants; hence they have been termed *Contra-stimulants*. Cold is the most unequivocal sedative. Aconite is a sedative with regard to the sensitive nerves; Digitalis, to the cardiaco-vascular organs.

3. ALTERATIVES.—These are neither stimulants nor sedatives merely. They give rise to some alteration in the nature or quality of vital action, probably by effecting a change in the composition of the organic tissues. This class includes nearly the whole of the articles comprising our Materia Medica.

1. *BRUNONIAN THEORY.*

Dr. John Brown[e] supposed that all living beings possess a peculiar principle, termed *excitability*, and which distinguishes them from inanimate bodies. The agents which support life are termed *exciting powers;* and these, acting upon the *excitability*, maintain life; in the language of Brown, they produce *excitement*. Whatever can modify the excitability, and produce a greater or less degree of excitement, are termed *stimulant powers:* these are either universal or local. When the exciting powers act moderately, *health* is produced: when they act with too great energy, they cause *indirect debility:* when with too little, they produce *direct debility*. According to this doctrine, all medicines are stimulants, and differ from each other in little more than the degree in which they exert their stimulant power: moreover, they cannot cause exhaustion (of the excitability) except by an excessive action; in other words, by producing previous over-excitement.

Considered in a therapeutical point of view merely, the following objections present themselves to this theory:—

1. Many agents produce exhaustion without previously occasioning any obvious over-excitement (as the respiration of sulphuretted hydrogen or hydrocyanic acid gases.)
2. Medicines differ from each other in something more than the degree of their power; compare together the effects of foxglove, ammonia, hydrocyanic acid, cinchona, mercury, alcohol, elaterium, and opium, and the truth of this remark will be obvious.
3. The great majority of our medicines act neither as stimulants nor sedatives merely; they alter the quality of the vital actions: and this alterative effect has been quite overlooked by the Brunonians.

2. *DOCTRINE OF CONTRA-STIMULUS.*

(New Italian Doctrine).

This doctrine is a modification of the preceding. It was advanced about the commencement of the present century by Rasori and

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[e] *The Works of Dr. John Brown,* by Dr. W. C. Brown. Lond. 1804.

Borda, and was subsequently adopted by Tommasini and some other distinguished Italian physicians.

It admits two classes of medicines, the one called *stimulants* or *hypersthenics*,—the other, *contra-stimulants* or *hyposthenics*. The first exalt, the second depress, the vital energies. Hence this doctrine obviates one of the objections to the hypothesis of Brown, since it admits the existence of agents possessing a positive power of reducing vital action.

The following is Professor Giacomini's[f] arrangement of medicines:—

CLASS I.—HYPERSTHENICS.

Order 1. *Cardiaco-vascular Hypersthenics.* Ammonia and its Carbonate.

Order 2. *Vasculari-cardiac Hypersthenics.* The Ethers.

Order 3. *Cephalic Hypersthenics.* Opium, Morphia, and Narcotina.

Order 4. *Spinal Hypersthenics.* Alcohol, Rum, Cherry Spirit, and Wine.

Order 5. *Gastro-enteric Hypersthenics.* Volatile Oils, Cinnamon, Cloves, and Nutmegs.

CLASS II.—HYPOSTHENICS OR CONTRA-STIMULANTS.

Order 1. *Cardiaco-vascular Hyposthenics.* Hydrocyanic Acid, Laurel Water, Bitter Almonds, Peach Leaves and Flowers, Black Cherries, Cantharides, Digitalis, Squills, Colchicum, White Hellebore, Cebadilla, Camphor, Peppermint, Sage, Chamomile, Venice Turpentine, Balsam of Copaiva, Juniper, Carbonic Acid, Nitre, Acetate of Potash, and Asparagus.

Order 2. *Vasculari-cardiac Hyposthenics.*

Sect. 1. *Arterial Vascular Hyposthenics.* Antimonials, Aconite, Ipecacuanha, Elder Flowers, Dulcamara, Sarsaparilla, Guaiacum, Sulphur, Sulphuret of Potash, Sulphuretted Mineral Waters, Ergot of Rye, Cinchona, Willow Bark, Iceland Moss, and Iron.

Sect. 2. *Venous Vascular Hyposthenics.* Sulphuric, Nitric, Hydrochloric, and Nitro-muriatic Acids, Chlorine, Oxalic, Citric, Acetic, and Boracic Acids, Mustard, and Scurvy-Grass.

Order 3. *Lymphatico-glandular Hyposthenics.* Mercurials, Iodine, Burnt Sponge, Bromine, Chloride of Barium, and Hemlock.

Order 4. *Gastric Hyposthenics.* Bismuth, Quassia, Calumba, Wormwood, Wormseed, Gentian, Taraxacum, and Bitters.

Order 5. *Enteritic Hyposthenics.* Tamarinds, Cassia, Prunes, Manna, Fixed Oils of Almonds, Olives, Linseed, and Castor, Cream of Tartar, Sulphates of Magnesia, Potash, and Soda, Carbonate of Magnesia, Senna, Rhubarb, Jalap, Aloes, Scammony, Purgative Elixir, Gamboge, and the Oils of Caper Spurge, and Croton.

Order 6. *Cephalic Hyposthenics.* Belladonna, Stramonium, Henbane, and Tobacco.

Order 7. *Spinal Hyposthenics.* Strychnia, Nux Vomica, St. Ignatius's Bean, Toxicodendron, Lead, Arnica, Asafœtida, and Valerian.

Contra-stimulants obviate or counteract the effects of stimulants. Thus Wine being universally admitted to be a stimulant, those agents, which relieve the inebriation produced by it, are denominated contra-stimulants. Reasoning thus, the supporters of this doctrine deny that purgatives stimulate the stomach or intestines; for though they evacuate the contents of the alimentary canal, yet their general effects are depressing. If it be objected, that their continued use causes inflammation, it is answered that the same effect is produced by the most powerful contra-stimulant,—cold; and they account for it by ascribing it to re-action, which, though a consequence of contra-stimulus, is not directly caused by it. But by the same process of reasoning, it would not be difficult to show that some of the substances which the Italian physicians denominate stimulants (as Opium), are really contra-stimulants, since they are frequently useful in relieving excitement. Indeed, the supporters of this doctrine are by no means agreed among themselves as to the stimulant or contra-stimulant quality of certain medicines; for some of them regard Cinchona as belonging to the class of stimulants, others to that of contra-stimulants.

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[f] *Trattato filosofico-sperimentale dei Soccorsi Terapeutici.* Padova, 1833-36.

It will be obvious, from the preceding remarks, that the supporters of the doctrine of contra-stimulants disregard, or overlook, the physiological or immediate effects of medicines, but direct their sole attention to the secondary effects or consequences, which are uncertain, and often accidental; for many of the agents denominated contra-stimulants do not always, or even frequently, relieve excitement, but often have the contrary effect. The founders of this doctrine have, therefore, assembled under the same head, substances causing the most dissimilar and opposite effects; while they have separated others whose general operation is very analogous. They assume the existence of certain diseases, which they call Sthenic, because they are produced by too much stimulus, and admit the existence of contra-stimulants, because certain agents sometimes, or frequently, relieve this state. In other words, they judge of the nature of a disease by the effect of the curative means, and of the virtues of medicines by the nature of diseases. So that if a disease, now supposed to be Sthenic, should hereafter prove to be Asthenic, the medicines used to relieve it would immediately pass from the class of contra-stimulants to that of stimulants!

But the most important objection to the doctrine of contra-stimulus is, that its supporters have totally overlooked that alterative action which nine-tenths of the most important articles of the Materia Medica evince. When we attentively watch the effects of medicines, it will become manifest that few of them excite or depress merely. Their most characteristic property is that of changing or altering the quality of vital action; and, among the more active of our medicinal agents, scarcely two agree in producing the same kind of alteration. This defect in the doctrine of contra-stimulus equally applies to the doctrine of Brown; and appears, to me, to be fatal to both hypotheses.

There is, however, one part of the doctrine of contra-stimulus which is interesting, since it has led to some useful practical results. It is asserted, that the doses of contra-stimulants should be proportioned to the degree of excitement; and that, when inflammatory action runs high, the patient can bear very large doses without any obvious evacuation; the disease being subdued wholly by the contra-stimulant effect upon the solids of the body. This asserted capability of bearing increased doses has been denominated *Tolerance* of medicines; and has led to the employment of medicines in much larger doses, and at shorter intervals, than were previously ventured on; and, in the case of Emetic Tartar, the practice has proved highly successful. But, if the hypothesis were true, the tolerance ought to decrease as the disease declines; which certainly does not hold good with respect to Emetic Tartar, as will be hereafter mentioned. The truth appears to be, then, that many medicinal substances may be administered with safety, and, in certain maladies, with advantage, in doses which were formerly unheard of; and for this fact we are indebted to the founders of the doctrine of contra-stimulus[g]. It must be admitted, however, that the effects of blood-letting, as observed in different diseases, favour the notion of the supporters of contra-stimulus with respect to the tolerance of remedies. It is well known that in certain maladies, as congestion or inflammation of the brain, large quantities of blood may be abstracted without causing syncope, and not only with impunity, but with benefit. In this case, therefore, the disease appears to confer a protective influence,—in other words, the state of excitement increases the tolerance of the remedy. But, on the other hand, in fever, intestinal irritation, dyspepsia, and cholera, the abstraction of a much smaller quantity of blood is attended with syncope; so that these maladies appear to diminish the tolerance of blood-letting. Dr. Marshall Hall has laid great stress on these facts[h], and proposes to employ blood-letting as a diagnostic to distinguish irritation from inflammation. Thus when we are doubtful whether a disease is encephalitis or intestinal irritation, he says "we must prepare the arm, open a vein, and then place the patient upright, and let the blood flow until the lips become pallid; if the case be encephalitis, an extreme quantity of blood will flow, even thirty or forty ounces, or more, before there is any appearance of syncope; if it be intestinal irritation, syncope occurs before one-fourth of that quantity of blood has left the circulating system[i]."

Thus assuming *the degree of tolerance of blood-letting in health* to be ℥xv., he says the *augmented tolerance* in congestion of the brain will be ℥xl.-l.—in inflammation of the serous and synovial membranes, ℥xxx.-xl.—in inflammation of the parenchyma of organs, ℥xxx.—and in inflammation of the skin and mucous membranes, ℥xvi. The *diminished tolerance* in fevers and eruptive fevers, he fixes at ℥xij.-xiv.—in delirium tremens and puerperal delirium, at ℥x.-xij.—in laceration or concussion of the brain, and in intestinal irritation, at ℥viij.-x.—in dyspepsia and chlorosis, at ℥viij.—and in cholera, at ℥vi.[j]

But though I admit the general fact that some diseases augment, while others lessen the tolerance of blood-letting, yet I am by no means prepared to admit all the inferences which Dr. Hall has drawn from this. The distinction which he sometimes makes between irritation and inflammation, is oftentimes more ideal than real; as when he endeavours to shew that the pleurisy caused by broken ribs is rather irritation than inflammation[k]. And, moreover, while we may fairly doubt whether blood-letting is capable of distinguishing inflammation from irritation, the propriety of resorting to so powerful an agent in doubtful cases, is fairly questionable. "In my opinion," observes my friend Dr. Billing, "before such a decided step is adopted, the physician ought to have made up his mind as to what is the nature of the disease[l]."

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[g] For further information respecting the doctrine of contra-stimulus, see *Della Nova Dottrina Medica Italiana. Prolusione alle Lezioni di clinica medica per l'Anno scolastico* 1816-1817, del Professore Tommasini. Firenze, 1817. *Quarterly Journal of Foreign and British Medicine and Surgery*, vol. iv. p. 213, Lond. 1822; *The Edinburgh Medical and Surgical Journal*, vol. xviii. p. 606; and the *Lancet*, vol. ii. for 1837-38, p. 696, 770, and 862.

[h] *Researches principally relative to the Morbid and Curative Effects of Loss of Blood.* 1830.

[i] *On the Diseases and Derangements of the Nervous System*, p. 352. Lond. 1841.

[j] *Introductory Lecture to a Course of Lectures on the Practice of Physic: delivered at the Medical School in Aldersgate Street*, p. 42. London [1834].

CHAPTER VIII.—ON THE CIRCUMSTANCES WHICH MODIFY THE EFFECTS OF MEDICINES.

The circumstances which modify the effects of medicines may be arranged under two heads; those relating to the medicine, and those relating to the organism.

1. Relating to the Medicine.—Under this head are included,—

a. State of Aggregation.—The state of aggregation of a medicine modifies the effect. Thus Morphia is more active in solution than in the solid state.

b. Chemical Combination.—The soluble salts of the Vegetable Alkalis are more active than the uncombined alkalis, and *vice versâ*, the insoluble salts are less active. Lead and Baryta are rendered inert by combination with Sulphuric Acid.

c. Pharmaceutical Mixture.—The modifications produced by medicinal combinations have been very ably described by Dr. Paris[m]. The objects to be obtained, he observes, by mixing and combining medicinal substances, are the following:—

I. *To promote the action of the basis or principal medicine:—*

α. By combining together several forms or preparations of the same substance: as when we conjoin the Tincture, Decoction, and Extract of Cinchona in one formula.

β. By combining the basis with substances which are of the same nature, that is, which are individually capable of producing the same effect, but with less energy than when in combination with each other: as when we prescribe a compound of Cassia Pulp and Manna.

γ. By combining the basis with substances of a different value, and which do not exert any chemical influence upon it, but are found, by experience, to be capable of rendering the stomach, or system, or any particular organ, more susceptible of its action: as when we combine Mercury with Antimony and Opium, to increase the activity of the former.

II. *To correct the operation of the basis, by obviating any unpleasant effects it might be likely to occasion, and which would pervert its intended action, and defeat the objects of its exhibition.*

α. By mechanically separating, or chemically neutralizing, the offending ingredient; as by digesting *Cetraria Islandica* in an alkaline solution, in order to remove the bitter principle, and to enable us to obtain a tasteless, but highly nutritious fecula.

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[k] *Lancet*, Nov. 4, 1837; and *Principles of Diagnosis, and of the Theory and Practice of Medicine*, p. 355. Lond. 1837.

[l] *First Principles of Medicine*, p. 67, foot note, 4th ed. Lond. 1841.

[m] *Pharmacologia*, 6th ed. vol. i. p. 267.

β. By adding some substance capable of guarding the stomach or system against its deleterious effects; as when we combine Aromatics with Drastics, to correct the griping qualities of the latter;—or Opium with Mercurials, to prevent the latter affecting the bowels.

III. *To obtain the joint operation of two or more medicines.*

α. By uniting those substances which are calculated to produce the same ultimate results, although by totally different modes of operation: as when we combine Digitalis and Potash to produce diuresis,—the first acting on the absorbents, the second on the secreting vessels of the kidneys.

β. By combining medicines which have entirely different powers, and which are required to obviate different symptoms, or to answer different indications: as when we combine Opium and Purgatives in painter's colic,—the first to relieve the spasm, the second to evacuate the contents of the intestinal canal.

IV. *To obtain a new and active remedy not afforded by any single substance.*

α. By combining medicines which excite different actions in the stomach and system, in consequence of which new or modified results are produced: as when we combine Opium (a narcotic) with Ipecacuanha (an emetic) to obtain a sudorific compound.

β. By combining substances which have the property of acting chemically upon each other; the result of which is, the formation of new compounds, or the decomposition of the original ingredients, and the development of their more active elements: as when solutions of Acetate of Lead and Sulphate of Zinc are mixed to procure a solution of the Acetate of Zinc: and when the Compound Iron Mixture of the Pharmacopœia is prepared.

γ. By combining substances, between which no other chemical change is induced, than a diminution, or an increase, in the solubilities of the principles, which are the repositories of their medicinal virtues: as when we combine Aloes with Soap, or an Alkaline Salt, to quicken their operation, and remove their tendency to irritate the rectum.

V. *To afford an eligible form.*

α. By which the efficacy of the remedy is enhanced; as in the preparation of Decoctions, Infusions, Tinctures, &c.

β. By which its aspect or flavour is rendered more agreeable; as when we exhibit medicines in a pilular form, or when we exhibit them in a state of effervescence.

γ. By which it is preserved from the spontaneous decomposition to which it is liable; as when we add some spirituous tincture to an infusion.

d. Organic peculiarities.—Vegetables have their medicinal properties considerably modified by the nature of the soil in which they grow, by climate, by cultivation, by age, and by the season of the year when gathered.

e. Dose.—The modifications produced in the effects of medicines by differences of dose, are well seen in the case of Opium, Mercurials, and Turpentine.

2. RELATING TO THE ORGANISM.—Under this head are included several circumstances, of which the most important are the following:—

a. Age.— One of the most distinctive characters of organised beings is that of undergoing perpetual mutation during the whole period of their existence; thus constituting the phenomena of age. In order the better to appreciate these changes, the life of man has been portioned out into certain periods of *ages,* as they have been termed, though as these pass imperceptibly into each other, there is no absolute or fixed distinction; and, consequently, the number of these periods has not been generally agreed on; some admitting only three, others four, five, six, seven, or even eight; the most popular number being seven.

Each period of life is characterised by certain conditions of the solids, by particular states of the functions, by a tendency to certain diseases, and by a different susceptibility to the influence of medicines.

The effects of medicines are modified both quantitatively and qualitatively, by the influence of age. Hufeland[n] has drawn up the following scale for different ages:—

Years.	25	20	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Doses.	40	35	30	29	28	27	26	25	24	23	22	21	20	18	16	13	10

Months.	11	10	9	8	7	6	5	4	3	2	1	½
Doses.	9		8		7		6		5	4	2	1

Suppose the dose at the end of the first year to be 1, then at the fifth it will be 2, at the fifteenth 3, and at the twenty-fifth 4. In the above table the dose for an adult is supposed to be 40 grains. Dr. Young[o] gives the following rule for determining the doses for children under twelve years of age:—"The doses of most medicines must be diminished in proportion of the age to the age increased by 12. For example, at two years old, to $\frac{1}{7} = \frac{2}{2 + 12.}$ At twenty-one, the full dose may be given." But no rule is of much value, as the degree of development is very unequal in different children of the same age. Moreover the rule that applies to one medicine will not hold good with respect to others. This is particularly obvious in the cases of Opium and Calomel: the first must be given to children with the greatest caution, and in excessively small doses, whereas the second may be given to them almost as freely as to adults. Acetate of Lead, Nitrate of Silver, Arsenious Acid, and some other metallic compounds, ought, perhaps, never to be prescribed internally for infants.

b. Sex.—The sex has an influence in the operation of medicines. Females differ from males in greater susceptibility of the nervous system, more excitability of the vascular system, and less energy or power in all parts. In these respects, indeed, they approach children. Women, therefore, require, for the most part, smaller doses of medicinal agents than men.

The periods of menstruation, pregnancy, and lactation, are attended with peculiarities in relation to the action of medicines. Drastic purgatives should be avoided during these states, especially the two first. Agents which become absorbed, and thereby communicate injurious qualities to the blood, are of course to be avoided during pregnancy and lactation, on account of the probable ill effects on the offspring.

c. Mode of life: Occupation.—These circumstances affect the susceptibility of the whole organism, or of different parts, to the influence of external agents.

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[n] *Lehrbuch der allgemeinen Heilkunde,* p. 84, 2^{te} Aufl. Jena, 1830.

[o] *Introduction to Medical Literature,* p. 453, 2d ed. Lond. 1823.

d. Habit.—The habitual use of certain medicinal or poisonous agents, especially narcotics, diminishes the influence which they ordinarily possess over the body. Of the truth of this statement we have almost daily proofs in those who are confirmed drunkards, chewers and smokers of tobacco, and opium-eaters. Instances of the use of enormous doses of opium, with comparatively slight effects, will be found in every work on pharmacology. One of the most remarkable I have met with, is that related by G. V. Zeviani [p]. A woman of the name of Galvani, during a period of thirty-four years, took more than *two cwt.* of solid opium!! When nineteen years old she fell down stairs, and divided her urethra by a knife. Although the wound healed, she was unable to pass her urine in the usual way, but vomited it up daily with excruciating pain, to relieve which, she resorted to the use of opium, the doses of which were gradually increased to 200 grains daily.

Dr. Kreysig [q] has recently published a case of vomiting of an urinous liquor.

The influence of acrid or irritating substances is but little diminished by repetition,—a remark which applies especially to bodies derived from the mineral kingdom. There are, indeed, a few instances illustrative of the effect of habit in lessening the sensible influence of inorganic agents, but their number is small. The most common is the tolerance obtained by the repeated use of Tartar Emetic in peripneumonia.

Several attempts have been made to account for the effect of habit. Some ascribe it to an increased power acquired by the stomach of decomposing the medicinal agent,—an explanation adopted, in the case of poisons, by Dr. Christison [r], and which he illustrates by reference to the increased facility acquired by the stomach of digesting substances which had at first resisted its assimilative powers. If this explanation were correct, we ought to observe the effect of habit principally when substances are swallowed, and little, or not at all, when they are applied to a wound, to the cutis vera, or other parts unendowed with digestive powers, and opium ought to have its usual effects in ordinary doses, on application to any part of the body of an opium-eater, except to his stomach. Müller [s], as I have before noticed [t], ascribes a great number of the instances of habituation to the substance affecting the composition of an organ, and losing its influence by saturation, while the part may still be susceptible of the action of another agent. But a strong objection to this hypothesis, is, that the effect of habit is observed principally in the case of narcotic vegetables, and is scarcely perceived in inorganic substances which evince the most powerful affinities for inorganic principles. The same physiologist ascribes part of the phenomena observed in the effects of habit, to the excitability of the organ being deadened by the stimulus being too often repeated.

e. Diseased conditions of the body.—Diseases of various kinds sometimes have a remarkable influence in modifying the effects of medicines; a fact of considerable importance in practice. One of the most striking instances is that of Opium in tetanus. A scruple of this substance has been given at one dose, and repeated every two or three hours for several days, without any remarkable effects being produced. The late Mr. Abernethy mentions in his lectures[u], a patient who had tetanus from a wound which he received at the time of the riots in the year 1780, to whom a scruple of opium was given every day, besides a drachm at night. When his body was opened, thirty drachms of opium were found undissolved in his stomach. It might perhaps be inferred, that the diminished effect arose from the want of solution of the medicine; and that this was Mr. Abernethy's opinion seems presumable from his advice as to the mode of using it in this disease. "Give it," says he, "repeatedly in small doses, so that it may liquefy." However, that the want of liquefaction, or solution, is not the sole cause of this diminished influence, is proved from the fact that the tincture is also less effective in tetanus than in health.

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[p] *Sopra un Vomito Urinoso*, in the "*Memorie di Matematica e Fisica della Societa Italiana.*" Verona, t. vi. 1792-4, p. 93.

[q] *British and Foreign Medical Review*, vol. ix. p. 551. Lond. 1840.

[r] *Treatise on Poisons.*

[s] *Op. cit.* p. 60.

[t] See p. 103.

Begin[v] tells us, that M. Blaise, in a case of tetanus, administered, in ten days, four pounds, seven ounces, and six drachms of Laudanum, and six ounces, four drachms, and forty-five grains of solid Opium! Begin[w] endeavours to explain these facts by assuming, that the stomach acquires an increase of assimilative power, so that it is capable of digesting these enormous quantities of opium, in consequence of which the usual narcotic effects do not take place. He supports this hypothesis by stating, that if, during tetanus, opium be injected into the veins in much smaller quantities, it produces its usual effects. But if this latter assertion be correct, it does not at all warrant Begin's assumption; and, bearing in mind that opium administered by clysters during tetanus is less powerful than usual, and also taking into consideration the case related by Mr. Abernethy, I think we have evidence sufficient to warrant our non-admission of this hypothesis. All, therefore, that can be said in the way of explanation is, that in tetanus the nervous system has undergone some change, by which its susceptibility to the influence of opium is considerably diminished.

Another example of the influence of disease in modifying the effects of medicines is seen in the difficulty of causing salivation by the use of Mercury in fever. I have repeatedly seen large quantities of Mercurials exhibited internally during this disease, and in some cases accompanied with mercurial frictions, without affecting the mouth; and, in general, such cases terminated fatally. I never saw a fatal case of fever in which salivation was fully established; but whether the recovery was the consequence of the mercurial action, or the salivation of the recovery, I will not pretend to decide, though the first is the more plausible view.

f. Climate.—The well-known influence of climate in modifying the structure and functions of the animal economy, and in promoting or alleviating certain morbid conditions, necessarily induce us to ascribe to it a power of modifying the effects of medicines. But it is difficult to obtain pure and unequivocal examples of it, in consequence of the simultaneous presence and influence of other powerful agents.

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[u] *Lancet*, vol. v. 1824, p. 71.
[v] *Traité de Thérapeutique*, t. ii. p. 701. Paris, 1825.
[w] *Op. cit.* t. i. p. 113.

g. Mind.—The effects of medicines are very much modified by the influence of the mind. Hufeland[x] knew a lady who, having conceived a violent aversion to clysters, was thrown into convulsions by the injection of a mixture of Oil and Milk. I have heard the most violent effects attributed to bread pills; which pills, the patients had been previously informed, exercised a powerful influence over the system. Much of the success obtained by empirical practitioners depends on the confidence which patients have in the medicines administered.

h. Race.—Differences of race have been supposed to give rise, in some cases, to differences in the action of medicines on the body. Thus Charvet[y] ascribes to this circumstance the different effects of Opium on the Javanese and Malays (both belonging to the Mongolian race) as compared with those produced on Europeans, Turks, and Persians (the Caucasian race). "The Javanese," says Lord Macartney[z], "under the influence of an extraordinary dose of opium, becoming frantic as well as desperate, not only stab the objects of their hate, but sally forth to attack, in like manner, every person they meet, till self-preservation renders it necessary to destroy them." A similar account is given by Raynal[a] of the effects of Opium on the Malays.

i. Temperaments.—Under the denomination of temperaments are included peculiarities affecting certain individuals, independent of race, and which consists in disproportions in the developement or activity of certain organs, by which the whole animal economy is influenced. The term temperament is derived from the Latin verb *tempero, to mix together*, or *to temper*, and is applied to certain conditions of the body formerly supposed to arise from variations in the proportion of the fluids of the body. Thus, when the fluids were thought to be in proper relative proportions, they were said to temper each other, and by so doing, to produce a perfect temperament. When the yellow bile was supposed to be in excess, it produced the choleric or bilious temperament; when black bile, the atrabilious or melancholic; when blood, the sanguineous; and lastly, when pituita or phlegm, the pituitous or phlegmatic. Although in modern times physiologists do not admit these notions, yet we cannot but acknowledge that individuals do present certain physical and functional peculiarities: and thus the existence of temperaments has been generally admitted, while the theory or explanation of them has varied with the prevailing doctrines of the day.

The number of temperaments has not been agreed on; Hippocrates admitted four, Boerhaave eight, others five. Under five heads, I think, we may include the leading varieties, which will then stand as follows:—

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[x] *Op. cit.* p. 80.

[y] *De l'Action comparée de l'Opium*, p. 59. Paris, 1826.

[z] *Embassy to China*, vol. i. p. 263-4. Lond. 1792.

[a] *Histoire Philosophique et Politique des Deux Indes*, t. 1er, p. 359. Genève, 1780.

1st. The *nervous* temperament, characterised by great susceptibility of the nervous system, and comparatively little muscular power.

2d. The *sanguine* temperament, known by great development of the vascular system. The functions are performed with considerable activity, but the strength is soon exhausted.

3d. The *muscular* temperament is characterised by great development of the locomotive organs (bones and muscles); but is accompanied by diminished nervous energy.

4th. The *relaxed* temperament, marked by deficiency of power and imperfect performance of all the functions, with a soft and flabby condition of the solids.

5th. The most *perfect* temperament is that in which all the organs and functions are properly balanced, and in which we have the greatest strength.

Each of these temperaments varies in regard to its susceptibility to the influence of medicinal agents. In the sanguine temperament, stimulants are to be employed very cautiously: in the nervous and relaxed temperaments, evacuants are to be used with great care.

k. Idiosyncrasy.—Under this denomination are included these peculiarities which affect the functions of organs, without having any obvious relation to development, and which are not common to a number of individuals. Its effect in modifying the effects of medicines and poisons is, in general, to increase their activity. Thus, some individuals are peculiarly susceptible of the action of Opium, some of Mercury, and others of Alcohol. The odour of Ipecacuanha will, in certain persons, produce short and difficult respiration, approaching almost to a paroxysm of asthma. The late Mr. Haden[a] has related a case in which two drachms and a half of Tincture of Colchicum produced death: the mother of the patient was also exceedingly susceptible of the action of colchicum even in very small doses. In some instances the effect of idiosyncrasy is to diminish the activity of the medicines. Thus some persons are exceedingly insusceptible of the action of Mercury.

l. Tissue or *Organ.*—The nature of the part to which a medicine is applied, has an important influence over the effect produced. The stomach, for example, is much more susceptible of medicinal impressions than the skin. Opium acts more powerfully on the system when applied to the serous than to the mucous tissues. Carbonic acid acts as a positive poison when taken into the lungs, but as a grateful stimulant when applied to the stomach. The modifications effected by the nature of the tissue will be more fully noticed hereafter.

CHAPTER IX.—ON THE THERAPEUTICAL EFFECTS OF MEDICINES.

The effects produced on diseases by the influence of medicines are denominated *therapeutical.* They are sometimes termed *secondary,* because, in a great majority of instances, they are subordinate to those already described under the name of physiological.

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[a] Dunglison's *Translation of Magendie's Formulary,* with Notes by C. T. Haden, Esq. p. 98, 4th ed. Lond. 1825.

Mode of Production.—Therapeutical effects are produced in two ways:—

1. *By the influence of a medicine over the causes of diseases.*—This may be *direct* or *indirect*. Medicines which act directly are termed by Hufeland[b] *specifica qualitativa.* As examples, the Chemical Antidotes may be referred to. Those anthelmintics (as Oil of Turpentine), which poison intestinal worms, also belong to this division. If the efficacy of Sulphur in the cure of itch depend on its destroying the *Acarus Scabiei*, this will be another instance of the direct operation of an agent on the cause of a disease. As an example of a medicine acting *indirectly*, I may mention the dislodgement of a biliary calculus, contained in the ductus choledochus, by the administration of Ipecacuanha as an emetic: or the removal, by a Purgative, of a morbid condition of system, kept up by the presence of some depraved secretion in the bowels, the result of a previous disease.

2. *By modifying the actions of one or more parts of the system.*—In a large majority of instances the causes of disease are either not known, or they are not of a material nature. In all such cases we administer medicines with the view of producing certain changes in the actions of one or more parts of the system, and thereby of so altering the diseased action as to dispose it to terminate in health. Thus inflammation of the lungs frequently subsides under the employment of nauseating doses of Tartarized Antimony; and Emetics will sometimes put a stop to the progress of hernia humoralis.

The medicines belonging to this division may be arranged in two classes; those which are applied to the diseased part, and, secondly, those which are applied to other parts.

a. Topical Agents. — Under this head we include Unguents or Lotions used in cutaneous diseases, ulcers, &c.; Gargles in affections of the mouth and throat; Collyria in ophthalmic diseases; and Injections into the vagina and uterus in affections of the urino-genital organs. In all such cases we can explain the therapeutic effect in no other way than by assuming that the medicine sets up a new kind of action in the part affected, by which the previous morbid action is superseded; and that the new action subsides when the use of the medicine is suspended or desisted from. Sometimes it may be suspected that the influence which certain medicines exercise in diseases of remote organs, arises from their particles being absorbed, and, through the medium of the circulation, carried to the parts affected. Thus the beneficial influence which the Turpentines occasionally exert in affections of the mucous membranes (as in gleet and leucorrhœa) may perhaps be owing to a topical influence of this kind; as also Strychnia in affections of the spinal marrow.

b. Medicines which indirectly influence diseased action.—Under this head I include all those agents operating on some one or more parts of the body, which have a relation with the diseased part. Thus Emetics may influence a disease by the mechanical effects of the vomiting which they induce. Alterations in the quantity of the food relieve diseases depending on morbid changes of the blood,—as when we substitute Fresh Meat and Vegetables, and the use of Vegetable Acids, for salt provisions in scurvy. Opium relieves spasm and pain, as in colic, and in the passage of calculi. Purgatives relieve cutaneous and cerebral affections; Diuretics, dropsies; Blisters, internal diseases, &c.

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[b] *Op. supra cit.* p. 19.

Fundamental Methods of Cure.—According to the homœopathists, there are only three possible relations between the symptoms of diseases and the specific effects of medicines—namely, *opposition*, *resemblance*, and *heterogeneity*. It follows, therefore, that there are only three imaginable methods of employing medicines against disease; and these are denominated *antipathic*, *homœopathic*, and *allopathic*.

1. *ANTIPATHIA.*

The *antipathic* (so called from ἀντι, *opposite*, and πάθος, *a disease*), *enantiopathic*, or *palliative* method consists in employing medicines which produce effects of an opposite nature to the symptoms of the disease, and the axiom adopted is "*contraria contrariis opponenda.*" Hippocrates may be regarded as the founder of this doctrine; for in his twenty-second Aphorism[c] he observes, that "all diseases which proceed from repletion are cured by evacuation; and those which proceed from evacuation are cured by repletion. And so in the rest; contraries are the remedies of contraries."

We adopt this practice when we employ Purgatives to relieve constipation; Depletives to counteract plethora; Cold to alleviate the effects of scalds; Narcotics to diminish preternatural sensibility or pain; and Opium to check diarrhœa.

But Purgatives are not to be invariably employed in constipation, nor Opium in pain. Reference must be constantly had to the cause of these symptoms. If confinement of bowels depend on a torpid condition of the large intestines, powerful purgatives may be administered with great benefit; but if it arise from acute enteritis or strangulated hernia, they will probably increase both the danger and sufferings of the patient. Again, Opium may be beneficially given to relieve the pain of colic, but it would be highly improper in all cases of acute pain, as in pleurisy.

The homœopathists object to antipathic remedies, on the ground that though the primary effects of these agents may be opposite to the phenomena of a disease, the secondary effects are similar to them. "Constipation excited by Opium (primitive effect) is followed by diarrhœa (secondary effect); and evacuations produced by Purgatives (primitive effect) are succeeded by costiveness, which lasts several days (secondary effect)[d]." The only mode of meeting statements of this kind is to appeal to experience. Is opium ever beneficial in diarrhœa? Are purgatives useful in any instances of constipation? The homœopathists reply to both of these questions—No. We answer—Yes. Here, then, we are at issue with them on a matter of fact.

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[c] *Aphorismi, Sectio* 2nda.

[d] Hahnemann, *Organon*, § lxi.

2. *Homœopathia.*

The *homœopathic* (so called) from ὅμοῖος, *like* or *similar*, and πάθος, *a disease*) method of treating diseases consists in administering a medicine capable of producing effects similar to the one to be removed, and the axiom adopted is "*similia similibus curantur.*"

Hahnemann's first dissertation on homœopathy was published in 1796, in Hufeland's Journal[f]. In 1805 appeared his "*Fragmenta de viribus medicamentorum positivis.*" But the first systematic account of this doctrine appeared in 1810, in a work entitled "*Organon der rationellen Heilkunde.*"

The following, says Hahnemann, are examples of homœopathic cures performed unintentionally by physicians of the old school of medicine:—

The author of the fifth book, Ἐπιδημιῶν, attributed to Hippocrates, speaks of a patient attacked by the most violent cholera, and who was cured solely by White Hellebore; which, according to the observations of Forestus, Ledelius, Reimann, and many others, produces of itself a kind of cholera. The English sweating sickness of 1415, which was so fatal that it killed 99 out of 100 affected with it, could only be cured by the use of Sudorifics. Dysentery is sometimes cured by Purgatives. Tobacco, which causes giddiness, nausea, &c. has been found to relieve these affections. Colchicum cures dropsy, because it diminishes the secretion of urine, and causes asthma in consequence of exciting dyspnœa. Jalap creates gripes; therefore it allays the gripes, which are so frequent in young children. Senna occasions colic; therefore it cures this disease. Ipecacuanha is effectual in dysentery and asthma, because it possesses the power of exciting hemorrhage and asthma. Belladonna produces difficult respiration, burning thirst, a sense of choking, together with a horror of liquids when brought near the patient; a flushed countenance, eyes fixed and sparkling, and an eager desire to snap at the bystanders; in short, a perfect image of that sort of hydrophobia which Sir Theodore de Mayerne, Münch, Buchholz, and Neimicke, assert they have completely cured by the use of this plant. When, indeed, Belladonna fails to cure canine madness, it is attributable, according to Hahnemann, either to the remedy having been given in too large doses, or to some variation in the symptoms of the particular case, which required a different specific—perhaps Hyoscyamus, or Stramonium. Drs. Hartlaub and Trinks have subsequently added another homœopathic remedy for hydrophobia — namely, Cantharides. Opium cures lethargy and stupor, by converting it into a natural sleep. The same substance is a cure for constipation. Vaccination is a protection from small-pox, on homœopathic principles. The best application to frost-bitten parts is Cold, either by the use of some freezing mixture or by rubbing the part with snow. In burns or scalds the best means of relief are the exposure of the part to Heat, or the application of heated Spirit of Wine or Oil of Turpentine.

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[f] See the *Preface to the English Translation of the "Organon."*

Hahnemann thinks that it is of little importance to endeavour to elucidate, in a scientific manner, how the homœopathic remedy effects a cure; but he offers the following as a probable explanation. The medicine sets up, in the suffering part of the organism, an artificial but somewhat stronger disease, which, on account of its great similarity and preponderating influence, takes the place of the former; and the organism from that time forth is affected only by the artificial complaint. This, from the minute dose of the medicine used, soon subsides, and leaves the patient altogether free from disease; that is to say, permanently cured. As the secondary effects of medicines are always injurious, it is very necessary to use no larger doses than are absolutely requisite, more especially as the effects do not decrease in proportion to the diminution of the dose. Thus eight drops of a medicinal tincture do not produce four times the effects of two drops, but only twice: hence he uses exceedingly small doses of medicines. Proceeding gradually in his reductions, he has brought his doses down to an exiguity before unheard of, and seemingly incredible. The millionth part of a grain of many substances is an ordinary dose; but the reduction proceeds to a billionth, a trillionth, nay, to the decillionth of a grain, and the whole materia medica may be carried in the waistcoat pocket!

The following is the method of obtaining these small doses:—Suppose the substance to be a solid; reduce it to powder, and mix one grain of it with ninety-nine grains of sugar of milk: this constitutes the *first attenuation.* To obtain the *second attenuation,* mix one grain of the first attenuation with a hundred grains of sugar of milk. The *third attenuation* is procured by mixing one grain of the second attenuation with ninety-nine grains of sugar of milk. In this way he proceeds until he arrives at the *thirtieth attenuation.* Water is the diluent for liquid medicines. The following table shows the strength of the different attenuations, with the signs he employs to distinguish them:—

1.	First attenuation	One hundredth part of a grain.
2.	Second	One thousandth.
I.	Third	One millionth.
II.	Sixth	One billionth.
III.	Ninth	One trillionth.
IV.	Twelfth	One quadrillionth.
V.	Fifteenth	One quintillionth.
VI.	Eighteenth	One sextillionth.
VII.	Twenty-first	One septillionth.
VIII.	Twenty-fourth	One octillionth.
IX.	Twenty-seventh	One nonillionth.
X.	Thirtieth	One decillionth.

Here is a tabular view of the doses of some substances employed by the homœopathists:—

Charcoal, one or two decillionths of a grain.
Chamomile, two quadrillionths of a grain.
Nutmeg, two millionths of a grain.
Tartar emetic, two billionths of a grain.
Opium, two decillionths of a drop of a spirituous solution.
Arsenious acid, one or two decillionths of a grain.
Ipecacuanha, two or three millionths of a grain.

These doses are given in pills (*globuli*,) each about the size of a poppy-seed.

Hahnemann gravely asserts, that the length of time a powder is rubbed, or the number of shakes we give to a mixture, influences the effect on the body. Rubbing or shaking is so energetic in developing the inherent virtues of medicines, that latterly, says Hahnemann, "I have been forced, by experience, to reduce the number of shakes to two, of which I formerly prescribed ten to each dilution[g]." In mixing a powder with sugar, the exact period we are to rub is, therefore, laid down: in dissolving a solid in water, we are told to move the phial "*circa axin suam*," and at each attenuation to shake it *twice*—"*bis, brachio quidem bis moto, concute.*[h]"

The principal facts to be urged against this doctrine may be reduced to four heads:—

1st. Some of our best and most certain medicines cannot be regarded as homœopathic: thus Sulphur is incapable of producing scabies, though Hahnemann asserts it produces an eruption analogous to it. Andral took quina in the requisite quantity, but without acquiring intermittent fever: yet no person can doubt the fact of the great benefit frequently derived from the employment of this agent in ague: the paroxysms cease, and the patient seems cured. "But," says Hahnemann, "are the poor patients really cured in these cases?" All that can be said, is, that they seem to be so: but it would appear, according to this homœopathist, that patients do not know when they are well. We are also told, that whenever an intermittent resembles the effects of Cinchona, then, and not till then, can we expect a cure. I am afraid, if this were true, very few agues could be cured. Acids and vegetable diet cure scurvy, but I never heard of these means causing a disease analogous to it.

2dly. In many cases homœopathic remedies would only increase the original disease; and we can readily imagine the ill effects which would arise from the exhibition of Acrids in gastritis, or of Cantharides in inflammation of the bladder, or of Mercury in spontaneous salivation.

3dly. The doses in which these agents are exhibited are so exceedingly small, that it is difficult to believe they can produce any effect on the system, and, therefore, we may infer that the supposed homœopathic cures are referrible to a natural and spontaneous cure, aided, in many cases, by a strict attention to diet and regimen. What effect can be expected from one or two decillionth parts of a drop of laudanum? Hahnemann says, it is foolish to doubt the possibility of that which really occurs; and adds, that the sceptics do not consider the rubbing and shaking bestowed upon the homœopathic preparation, by which it acquires a wonderful development of power!

4thly. Homœopathia has been fairly put to the test of experiment by some of the members of the *Académie de Médecine*, and the result was a failure. Andral tried it on 130 or 140 patients, in the presence of the homœopathists themselves, adopting every requisite care and precaution, yet in not one instance was he successful[i].

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[g] *Organon.*

[h] See Dr. Quin's *Pharmacopœia Homœopathica.*

[i] See *Medical Gazette*, vol. xv. p. 922.

3. ALLOPATHIA.

The *allopathic* (so called from ἄλλος, *another*, and πάθος, *a disease*), or *heteropathic* method, consists in the employment of medicines which give rise to phenomena altogether different or foreign (neither similar nor exactly opposite) to those of the disease.

Under this head is included that mode of cure effected by what is called *Antagonism* or *Counter-irritation;* that is, the production of an artificial or secondary disease, in order to relieve another or primary one. It is a method of treatment derived from observation of the influence which maladies mutually exert over each other. For example, it has been frequently noticed, that if a diarrhœa come on during the progress of some internal diseases, the latter are often ameliorated, or perhaps rapidly disappear, apparently in consequence of the secondary affection. The result of observations of this kind would naturally be the employment of alvine evacuants in other analogous cases where diarrhœa did not spontaneously take place: and this practice is frequently attended with beneficial results. The appearance of a cutaneous eruption is sometimes a signal for the disappearance of an internal affection; and *vice versâ*, the disappearance of a cutaneous disease is sometimes followed by disorder of internal organs. Here, again, we have another remedy suggested, namely, the production of an artificial disease of the skin, as by Blisters, by an ointment containing Tartar Emetic, or by other irritating applications;—a suggestion, the advantage of which experience has frequently verified. I might bring forward numerous other examples to prove the fact (which, however, is so well known as to require little proof), that action in one part will often cease in consequence of action taking place in another. Diseases, then, appear to have what Dr. Pring[k] calls a *curative relation* with respect to each other; and we shall find that the greater part of our most valuable and certain remedies operate on the principle of antagonism or counter-irritation; that is, they produce a secondary disease which is related to the primary one. Dr. Parry[l] calls this the "*cure of diseases by conversion*."

Vomiting is a powerful means of relief in bubo, as well as in swelled testicle. Mr. Hunter says, he has seen bubo cured by a vomit. I have frequently seen the progress of swelled testicle, in gonorrhœa, stopped by the exhibition of full doses of Tartar Emetic. Now, it is very improbable that the benefit arises from the mere evacuation of the contents of the stomach. The only plausible explanation to be offered, is, that the Emetic sets up a new action in the system, which is incompatible with that going on in the groin or in the testicle. If this notion be correct, Emetics act in these cases as counter-irritants. The efficacy of Purgatives, in affections of the head, is best accounted for by supposing that they operate on the principle of counter-irritation. Blisters, Cauteries, Issues, Moxa, and other remedies of this kind, are generally admitted to have a similar mode of operation. Even the efficacy of Blood-letting, in inflammatory affections, is better explained by assuming that this agent induces some new action incompatible with the morbid action, than that it is merely a debilitant. The immediate effect sometimes produced on disease, by this remedy, is so remarkable as hardly to admit of the supposition of its acting as a mere weakening agent. One full blood-letting will sometimes put an immediate stop to ophthalmia: and I have seen, even while the blood was flowing, the vascularity of the eye diminish, and from that time the disease progressively declined. When to this fact we add, that the same disease is often successfully treated by other different, and even opposite remedies, such as Mercury and stimulant applications, we find a difficulty in explaining their beneficial agency, except by supposing that they influence disease by some relation common to all of them. This view of the counter-irritant operation of blood-letting is supported by Dr. Clutterbuck[q], Dr. Pring[r], and others. The term *counter-irritant* is, however, objectionable, since literally it expresses that the secondary disease should be a state of irritation,—a term hardly applicable to the condition caused by blood-letting. But this, as well as other remedial agents (mental impressions, for example), agrees with the counter-irritants, commonly so called (blisters, &c.) in influencing diseases only by an indirect relation: it would be better, therefore, either to extend the meaning of the term counter-irritant, or to employ some other, such as *counter-morbific.*

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[k] *An Exposition of the Principles of Pathology*, p. 352, *et seq.* Lond. 1823.
[l] *Elements of Pathology and Therapeutics*, 2nd edit. 1825.

The older writers employed two terms, *Revulsion* and *Derivation;* the first was applied to those cases in which the secondary disease occurred in a part remote from the seat of the primary affection; the second was, on the contrary, confined to those instances in which the secondary was produced in the neighbourhood of the primary disease. For example, Leeches or Blisters applied to the feet in apoplexy were called revulsives; but the same applications to the head, in the same disease, would be derivatives. There is, however, no real distinction between them, their operation being similar; for revulsion was, even in their own sense of the word, only derivation at a distant part.

Topical applications are frequently counter-irritants. Thus, stimulant washes, applied to the eye, sometimes cure ophthalmia. They operate, apparently, by altering the morbid action, and substituting a milder and more easily cured disease for the one previously existing.

Using the term counter-irritation in its most extended sense, we see our list of agents producing this effect is a most extensive one. It comprehends Emetics, Purgatives, Diffusible Stimulants, Mercury, Blisters, Cauteries, Issues, Setons, Moxa, Blood-letting, (including Arteriotomy, Venesection, Cupping, and Leeches), Irritating Lavements, Frictions, Sinapisms, Rubefacients, the Hot and Cold Baths, and even Mental Impressions. That is, all these agents excite some action in the system which has a relation (oftentimes beneficial) with the morbid action: to use Dr. Parry's words, these agents cure disease by *conversion.*

The most unsatisfactory part of the subject is, the theory or hypothesis of the manner in which the mutual relations of diseased actions are effected. Dr. Parry presumes most diseases consist in local determinations of blood, and that it is a law of the human constitution that excessive morbid determination to two different parts shall not exist in the same person at the same time. Neither of these assumptions, however, is quite correct; but, if both were true, they still leave untouched the question, how determination of blood to one organ is cured by producing a determination to another. To account for it, some assume that the system can produce only a certain quantity of nervous energy, and that as, in every disease, there is an undue or preternatural distribution of nervous energy, so the production of an artificial disease in one part must, by consuming the nervous energy, diminish the disease in another. But the whole hypothesis is grounded on assumptions perfectly gratuitous and incapable of proof. As Dr. Pring justly observes, were this hypothesis true, it would lead us to employ, not bleeding, purgatives, blisters, and all indirect remedies in hepatitis or consumption, but the exercise of the treadmill for a few hours; so that a patient, labouring under phrenitis or pneumonia, should be made to walk fifteen or twenty miles a day, by which, it would be presumed, so much nervous energy would be consumed in the arms and legs, that there could not possibly be any preponderance or excess in any other seat.

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[q] *Lectures on the Theory and Practice of Physic,* published in the *Lancet,* vol. x. 1826.
[r] *Op. cit.* pp. 465-8.

Let us, then, discard absurd hypotheses of this kind; and, for the present, be content with the knowledge of the fact, that one disease, whether artificially or spontaneously generated, will often, but not invariably, supersede another[m].

The *Antagonisms* of determinations of blood and of the secretions have been before noticed[n]. Müller[o] states, that the antagonism of the secretions is subject to the following laws:—

1. The increase of a secretion in a tissue, *a*, which is less irritable than the organ, *b*, is incapable of producing a diminution in the secretion of the latter; hence, for example, artificially excited secretions from the skin, as by a blister, in the neighbourhood of the eye, in inflammation of the latter organ, are of no service, because the eye is a more irritable part than the skin.

2. An increased secretion in a certain tissue, *a*, cannot be diminished by exciting the same secretion in another part of the same tissue, *a*; on the contrary, such a procedure would rather increase the secretion from all parts of the tissue than diminish it, because the relation which exists between the different parts of one and the same tissue is that of sympathy, not of antagonism. Hence, a discharge from the generative or urinary organs cannot be arrested by an artificially excited diarrhœa.

3. On the contrary, the secretions of tissues which do not belong to the same class of structures, often antagonise each other. Thus, increase of the cutaneous secretion frequently induces diminution of the secretion of the kidneys: in summer, the cutaneous exhalation is more abundant, and the urinary secretion proportionally scanty; in winter, the reverse is the case. Effusion of watery fluids into the cellular membrane and serous cavities is attended with dryness of the skin, and diminution of the urinary secretion, the quantity of which is observed to increase in the same proportion as dropsical effusions diminish. Suppression of the exhalation from the skin by cold, gives rise to mucous discharges from the intestinal and pulmonary mucous membranes.

4. It is only towards the termination of consumptive diseases that this relation

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[m] For further information on this subject, consult Hunter's *Treatise on the Blood, Inflammation, and Gun-shot Wounds.* Lond. 1794.—*Dict. des Sciences Médicales*, art. *Révulsion*, by MM. Pinel and Bricheteau.—*Dict. de Médécine*, art. *Derivatif*, by Guersent.—J. C. Sabatier, *Les Lois de la Révulsion, étudiées sous le Rapport Physiologique et Therapeutique.* Paris, 1832.

[n] See p. 9.

lements of Physiology, by Baly, vol. i. p. 473—4.

of antagonism between the secretions ceases to exist; when, in consequence of the relaxed state of the tissues, all are at length increased in quantity; in the colliquative state that precedes death in phthisical patients, colliquative diarrhœa, profuse sweating, and dropsical effusions, take place simultaneously.

5. When one tissue is excited to increased action by an impression made upon another, either the secretion of the two must have been in some respects similar, as in the case of the skin and kidneys, both of which have the office of excreting water from the blood; or the organ thus excited must have had a predisposition to morbid action, which is the rational explanation for the circumstance, that the impression of cold produces in one person an affection of the mucous membrane of the lungs; in another, a disordered secretion of mucus in the intestinal canal.

CHAPTER X.—OF THE PARTS TO WHICH MEDICINES ARE APPLIED.

Medicines are applied to the skin; to mucous or serous membranes; to wounds, ulcers, or abscesses; or they are injected into the veins.

1. *Applications to the Skin.*

Medicinal applications are frequently made to the skin in order to produce local effects, as in the case of Blisters, Cataplasms, Fomentations, Lotions, Embrocations, &c.; and occasionally to affect remote parts of the system, as when we use Mercury. Most, if not all medicines, which influence distant organs by application to the skin, do so in consequence of their absorption; and, as the cuticle offers a mechanical impediment to this process, we generally either remove it or make use of friction.

There are three methods of applying medicines to the skin; namely, the *enepidermic*, the *iatraleptic*, and the *endermic*.

1. The Enepidermic Method consists in the application of medicines to the skin, unassisted by friction; as when we employ Plasters, Blisters, Poultices, Lotions, Fomentations, Baths, &c.

Baths are made of liquids (as simple water), soft substances (as hot dung and saline mud), dry bodies (as sand), gases (as hot air), or vapours (as aqueous vapour). Gases or vapours are sometimes applied to the skin, either as local agents, or as means of affecting the constitution. Thus, baths of sulphurous acid gas are employed in itch; chlorine gas is recommended as an application to the skin in liver complaints; vapours of various mercurial preparations have been employed to excite salivation. The vapour of hot water, holding in solution the volatile matters of vegetables, has been employed in the treatment of many diseases, under the name of *medicated vapour baths;* though the greater part of their efficacy is to be ascribed to the influence of the vapour.

2. The Iatraleptic Method (which has been so called from *ἰατρεύω, to cure* or *heal:* and *'αλείφω, to anoint*), consists in the application of medicines to the skin, aided by friction. It has been termed the *epidermic method*—sometimes *anatripsologia* (from *ἀνατρίβω, to rub in;* and *λόγος, a discourse*), and also *espnoïc medicine.* It was employed by Hippocrates, and other old writers; but fell into disuse,

until attention was again drawn to it by Brera, Chiarenti, Chrestien[p], and others. Among the substances which have been employed in this way, are Camphor, Digitalis, Squills, Cantharides, Sulphate of Quina, Veratria, Colocynth, Rhubarb, Opium, Belladonna, Mercury, Chloride of Gold, &c.

The mode of employing medicinal agents, according to the iatraleptic method, is the following:—The substance to be applied being reduced to the finest possible state of division, is to be dissolved or suspended in some appropriate liquid, and in this state rubbed into the skin. The dose is always considerably larger than for the stomach—generally two or three, often as much as ten, and, in some cases, even twenty times the ordinary dose: but no absolute rule can be laid down on this head. The liquids employed to dissolve or suspend the medicine may be water, spirit, or oily or fatty matter. Iatraleptic writers, however, prefer the gastric juice, or saliva, or even bile; but I am not acquainted with any just grounds for this preference. Collard de Martigny[q] concludes from his experiments, that the palms of the hands, soles of the feet, neighbourhood of the joints, the chest, the back, and the inner parts of the limbs, are to be preferred for the application of medicines.

The objections to this mode of employing medicines are the uncertainty of results; the time required to affect the system; the frequently unpleasant nature of the process (as when mercurial inunctions are employed); and the local irritation sometimes produced by the friction. Notwithstanding these, however, it may be resorted to occasionally with advantage; as where the patient cannot or will not swallow, or where the alimentary canal is very irritable, or insensible to the action of medicines.

3. THE ENDERMIC, OR EMPLASTRO-ENDERMIC METHOD, consists in the application of medicinal agents to the denuded dermis. For its introduction into practice we are indebted to MM. Lembert and Lesieur[r].

The denudation of the dermis is usually effected by a blistering plaster. When the cuticle is elevated, an opening is to made into it, in order to allow the serum to escape. The medicine is then applied to the dermis either with or without removing the cuticle. At the first dressing the transparent pellicle formed by the dermis is to be carefully removed, as it very much impedes absorption. The medicine is applied to the denuded surface, either in its pure state, in the form of an impalpable powder—or, if too irritating, it is to be incorporated with gelatine, lard, or cerate. Should any circumstances arise to lead us to fear that the quantity of the medicine applied has been too large, the mode of proceeding is the following:—Cleanse the surface immediately; make compression (as by a cupping-glass) around the denuded part, in order to prevent absorption, and apply any substance that will neutralize the effect of the medicine. Thus, Lembert has found, that two grains of the Acetate of Morphia will destroy the tetanic symptoms caused by the application of two grains of Strychnia. Musk and Camphor are said to counteract the narcotism of Morphia[s].

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[p] *De la Méthode Iatraleptique.* Paris, 1811.

[q] *Dict. de Médec. et de Chirurg. pratiq.* art. *Iatreleptie.*

[r] *Essai sur la Méthode Endermique*, par A. Lembert. Paris, 1828.

Instead of a blistering plaster, Trousseau recommends a vesicating ointment, composed of equal parts of a strong solution of ammonia and lard. Two applications, of five minutes each, are sufficient to raise the cuticle. Boiling water, which has been employed by some persons, is uncertain, painful, and dangerous: it may cause mortification of the dermis, and thus stop absorption.

The advantages of the endermic method are, that substances are not submitted to the influence of the digestive process, and their pure effects can be better ascertained;—their operation is in general very quick, and in some cases more rapid than when they are applied to the stomach. If the gastric membrane be inflamed, or if the patient cannot (or will not) swallow, more especially if the case be urgent, this is an admirable method of putting the system under the influence of a medicine.

The disadvantages of the endermic method are, the pain sometimes experienced by the application of medicinal agents to a denuded surface—some even may occasion mortification of the part; the possibility of the skin being permanently marked; lastly, some substances have no effect when used endermically.

The substances which have been used by this method are Morphia, and its Acetate, Hydrochlorate, and Sulphate, in doses of from a quarter of a grain to two grains; Strychnia, from a quarter of a grain to a grain; Aconitina, one-sixteenth to one-eighth of a grain; Extract of Belladonna, three or four grains; Sulphate of Quina, two to six grains; Musk, six or eight grains; Tincture of Asafœtida, ten minims. Many other agents have also been employed endermically: as Digitalis, Extract of Squills, Aloes, Saffron, Bichloride of Mercury, Tartar Emetic, &c.[t]

Method by Inoculation.—In connection with the endermic method may be mentioned another mode of employing medicines; namely, the method by inoculation proposed by M. Lasargue de St. Emilion[u]. In this way Morphia has been employed to relieve topical pain. It is introduced in the part in pain by the point of a lancet. In a few minutes a papula makes its appearance and an erythematous blush.

2. *APPLICATIONS TO THE MUCOUS MEMBRANES.*

We have two mucous membranes, to the different parts of each of which we apply medicines: the first is *the gastro-pulmonary membrane*, the second *the urino-genital*.

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[s] Ahrensen, *Dissert. de Methodo Endermatico*. Hauniæ, 1836.—Reviewed in the *Brit. and Foreign Med. Review*, for April, 1838, p. 342.

[t] For further information on the endermic method, consult, besides Lembert's Essay before quoted, the article *Endermique Méthode*, by Bouillaud, in the *Dict. de Médec. et Chirurg. pratiques*; also some articles, by Dr. Bureaud Riofrey, in the *Continental and British Medical Review*, vol. i. pp. 66, 321, and 385; and Richter, in *Lond. Med. Gaz.* Nov. 10, 1838.

[u] See the *Continental and British Review*, vol. i. pp. 41 and 388; and *Lancet*, for 1836-37, vol. i. p. 826.

1. GASTRO-PULMONARY MEMBRANE.

a. Ocular mucous membrane (conjunctiva).
b. Nasal or pituitary membrane.
c. Bucco-guttural membrane.
d. Eustachian membrane.
e. Aërian or tracheo-bronchial membrane.
f. Gastro-intestinal membrane.
g. Recto-colic membrane.

2. URINO-GENITAL MEMBRANE.

a. Urethro-vesical membrane.
b. Vagino-uterine membrane.

1. GASTRO-PULMONARY MEMBRANE: *a. Ocular mucous membrane* or *conjunctiva.*—Medicines are applied to the conjunctiva, to excite local effects only, though we might employ this part for other purposes, since remote organs may be affected by it. Thus a drop of Hydrocyanic Acid applied to the conjunctiva of a dog produces immediate death. The term *Collyrium* (Κὸλλύριον) was formerly employed to indicate solid substances applied to the eyes. It now usually means liquid washes for the eyes, and is equivalent to *eye-water.* Cottereau[v] calls all medicines (solids, soft substances, liquids, and vapours or gases), which are applied to the eyes, collyria.

b. Nasal or *pituitary membrane.*—We seldom apply medicines to the *pituitary* membrane except in affections of the nose or of parts adjacent. Sometimes they are employed to irritate and excite a discharge; they are then called *errhines;* but when used to produce sneezing, as when foreign bodies are in the nasal cavities, they are termed *sternutatories* or *ptarmics.*

c. Bucco-guttural mucous membrane.—Medicines are very rarely applied to the *mouth* and *throat*, except for local purposes. However, it has been proposed to excite salivation by rubbing calomel into the gums. Solids used in the mouth are termed *lozenges* (*trochisci*) or *masticatories*, according as they are allowed to dissolve slowly or are masticated; liquids are called *collutoria* or *gargarismata.* Powders (as that of Alum) are introduced by insufflation.

d. Eustachian membrane.—Aurists now and then apply washes to the *Eustachian tubes* in local affections; but the occasions for this practice are rare, and the operation difficult, except in practised hands.

e. Aërian or *tracheo-bronchial membrane.*—Accidental observation, as well as experiment, has shewn that medicines produce very powerful effects on the membrane lining the *trachea* and *bronchial tubes.* For the most part, applications here are made use of for local purposes, as in asthma, chronic bronchitis, phthisis, &c. though occasionally to affect the brain, the blood, the heart, &c. Dr. Myddleton[w] has advocated, in pulmonary diseases, the inhalation of substances (as Cinchona, Sulphate of Iron, Myrrh, &c.) reduced to an impalpable powder. The fumes (*suffitus*) of Tar, Balsam, Resins, and other burning bodies, have also been employed in these cases. Sir Alexander Crichton[x] has strongly recommended Tar Vapour; the method of using which is the following:—The Tar employed should be that used in the cordage of ships; to every pound of which half an ounce of Carbonate of Potash must be added, in order to neutralize the Pyroligneous Acid generally found mixed with the tar, the presence of which will necessarily excite coughing. The tar thus prepared is to be placed in a suitable vessel over a lamp, and to be kept slowly boiling in the chamber during the night as well as the day. The vessel, however, ought to be cleansed and replenished every twenty-four hours, otherwise the residuum may be burned and decomposed,—a circumstance which will occasion increased cough and oppression on the chest.

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[v] *Traité Elémentaire de Pharmacologie.* Paris, 1835.

[w] *A Preliminary Dissertation illustrative of a new System of Pulmonary Pathology.* Bath, 1825.

[x] *Practical Observations on the Treatment and Cure of several Varieties of Pulmonary Consumption; and on the Effects of the Vapour of Boiling Tar in that Disease.* 1823.

The inhalation of aqueous vapour (*halitus*), either alone or with other substances, is oftentimes useful in various affections of the lungs and of the throat, &c. The apparatus for this purpose may be that proposed by Dr. Gairdner[y] or Dr. Mudge's inhaler, or in the absence of these, a teapot, or basin with an inverted funnel. In many asthmatic cases the difficulty of breathing is so great, that the patient cannot close the mouth around the tube, especially if the latter be small, without exciting a sense of impending suffocation. In such instances I have found the only easy and practical method of enabling the patient to inhale is, by holding the mouth over hot water contained in a basin or teacup. Various narcotic and emollient herbs are sometimes added to the water, but I suspect without contributing in any way to its efficacy. The vapour of hot Vinegar, of Sulphuric Ether, of Iodine, of Camphor, and of other volatile bodies, is occasionally employed in pulmonary diseases. The vapour of Iodine may be conveniently inhaled by means of a double-necked glass bottle (fig. 20), into which we introduce about an inch of water, to which a few drops of the Tincture of Iodine have been added. Through one of the necks a straight glass tube passes, and dips under the surface of the water. The other neck has a short curved glass tube passing through it, by which the patient inhales. In the absence of a double-necked bottle, a common wide-mouthed bottle (fig. 21) may be used, the cork of which has two perforations, through which pass the glass tubes. Sir C. Scudamore[z] uses a saturated Tincture of Conium along with Tincture of Iodine. Chlorine gas may be inhaled in a similar manner, using a solution of the gas, or of Chloride of Lime, instead of the Tincture of Iodine. If Oxygen, or Nitrous Oxide, be inhaled, the most easy and convenient mode of

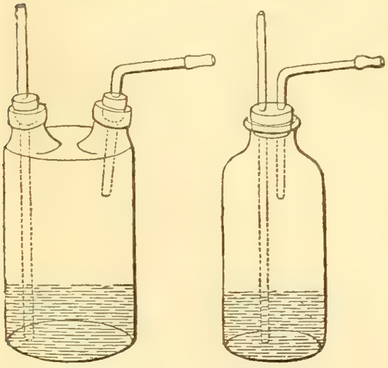

Fig. 20. Fig. 21.

Inhaling bottles.

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[y] *Edinburgh Medical and Surgical Journal*, vol. xix.

[z] *Lond. Med. Gaz.*, Feb. 7, 1840.

effecting it is from a bladder; but for other and more complete, though more costly methods, I must refer to the works of the late Dr. Beddoes, and of the celebrated engineer, Mr. James Watt[a].

f. Gastro-intestinal membrane.—We employ both extremities of the *alimentary canal* for the exhibition of medicines; the upper, however, more frequently than the lower. This mode of employing medicines is called the *method by ingestion.* Of all parts of the body, the gastro-intestinal surface is the most useful for the application of medicines. This arises from the great susceptibility, the active absorbing power, and the numerous relations which the stomach has with almost every part of the body. In many cases remote effects are more easily produced by this than by any other organ, as in the case of Diffusible Stimulants. Medicines which act by absorption are more energetic when applied to the serous membranes, the bronchial membrane, the cellular tissue, &c. In some cases it is not only possible, but probable, that the stomach may either partially or wholly digest a medicine.

g. Recto-colic membrane.—Sometimes, though less frequently than the stomach, the *rectum* is employed for the application of medicines. It has been asserted that the general susceptibility of the rectum is only one-fifth of that of the stomach, and that medicines take five times as long to operate by the former as by the latter: hence it has been said that both the dose, and the interval between the doses, should be five times as great as when applied to the stomach. But this assertion is far from being universally correct, though it may be so occasionally. Orfila asserts that those agents which operate by absorption, as Opium and Tobacco, are more active by the rectum than by the stomach; and he assigns as a reason the greater venous absorption of the rectum, and its less digestive power. But this statement is in direct opposition to the experience of almost every practitioner. Whenever I have had occasion to employ Opium by way of enema, I always exhibit twice or three times the ordinary dose, without exciting any remarkable effects. Dr. Christison states that he has given two measured drachms of Laudanum by injection, without producing more than usual somnolency; a quantity which, if Orfila's statement were correct, would probably prove fatal.

We apply medicines to the rectum sometimes with the view of alleviating disease of this or of neighbouring organs (as of the uterus, bladder, prostate gland, &c.); at other times in order to irritate the rectum, and, on the principle of counter-irritation, to relieve distant parts (as the head); sometimes to produce alvine evacuations, or to dissolve hardened fæces; occasionally, also, when we are precluded from applying our remedies to the stomach, on account of their unpleasant taste and smell, the inability or indisposition of the patient to swallow, or the irritability of the stomach; and, lastly, in order to destroy the small thread-worm (*Ascaris vermicularis*).

When the substances applied to the rectum are solid, we name them *suppositories* (*suppositoria*, from *suppono, to put under*); but when of a fluid nature, they are termed *clysters, lavements*, or *enemata*.

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[a] *Considerations on the Medicinal Uses, and on the Production of Factitious Airs.* 1796.

Formerly *suppositories* were conical, or cylindrical, like a candle, and of variable size,—sometimes one or two inches long. They are now usually made globular, and of small size. They are employed to evacuate the bowels; to irritate the rectum, and thereby to relieve affections of distant organs; but more commonly to act as local agents in affections of the rectum, bladder, uterus, prostate gland, urethra, &c. I have frequently employed with great advantage a mixture of Opium and Soap, to prevent the pain of priapism during the night, in gonorrhœa[b].

Clysters or *lavements* require to be considered under several points of view: *first*, in reference to the material of which they are made, and which must vary with the object for which these remedies are employed; *secondly*, with respect to the quantity of liquid used, and which will depend on the age of the patient. The average quantity for an adult is about twelve or sixteen ounces; and I believe that it is rarely proper to use more than this. I am quite sure that the practice of introducing several pints of fluid into the large intestines, with the view of exciting alvine evacuations, is bad. In the first place it often provokes the contraction of the gut, by which the injection is immediately returned; and, secondly, repeated distension diminishes the susceptibility of the part, so that the ordinary accumulation of fæcal matter no longer acts as a sufficient stimulus. Mr. Salmon[c] has related a case of this kind, where the patient had nearly lost all power of relieving the bowels, except by enemata or purgatives, and had produced dilatation of the rectum, in consequence of having been in the habit of introducing into the intestine two quarts of gruel twice every day. A newly-born infant requires about one fluidounce; a child of one to five years, from three to four ounces; and a youth from ten to fifteen, from six to eight fluidounces. *Thirdly*, the impulse with which the fluid ought to be thrown up, deserves attention. If too much force be used, the sudden dilatation of the gut may bring on spasmodic action of its lower part, by which the clyster will be returned. *Fourthly*, the instruments by which the injection is effected, require notice. The common pipe and bladder are too well known to require description. I am inclined to think that the most convenient, safe, and useful apparatus, is the elastic bottle and tube. Any quantity of liquid, however small, may be thrown up with the greatest ease, and without any danger of the impulse being too great. Its application is exceedingly convenient; a lusty person, by placing one foot on a stool or chair, may easily apply it without assistance; and its price is very moderate. Another form of enema apparatus is a narrow water-proof tube, holding about a pint of liquid, about four feet long, narrower at one end, which is furnished with a common injecting pipe, and about two and a half inches in diameter at the other. The fluid being placed in the tube, the pipe is introduced into the rectum, and the apparatus held in a perpendicular direction, by which the fluid is propelled into the gut by its own gravity. This apparatus, although very simple, appears to me to be less convenient for common use than the elastic bottle, and not to be well adapted for the administration of small quantities of fluids. In the shops are sold syringes, of various forms, as enema apparatus.

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[b] For some remarks on Suppositories, by Dr. Osborne, see *Lond. Med. Gaz.*, March 6, 1840.

[c] *Practical Essay on Prolapsus of the Rectum*, p. 24. Lond. 1831.

Gaseous matters have been sometimes thrown into the rectum. Thus the injection of common air has been proposed in ileus[d]. Tobacco-smoke has sometimes been employed in hernia: it is injected by a peculiarly constructed pair of bellows. Carbonic acid gas has been used in ulceration of the rectum.

2. *Urino-genital membrane.* *a. Urethro-vesical membrane.*—Applications to the *urethra* are made only for local purposes; either in a solid form, as caustic or medicated Bougies, or in that of a liquid, as an injection: the latter is easily applied by a common syringe. Syringes of various kinds, for this purpose, are sold by Messrs. Maw, of Aldersgate Street, London.

Injections are sometimes thrown into the *bladder*, but always for local purposes. The operation is easily performed by attaching a catheter to an elastic bottle.

b. Vagino-uterine membrane.—Medicines are applied to the *vagina* and *uterus*, to produce local effects only. Thus injections are made to relieve vaginal discharges, to excite the catamenia, &c. They are usually liquids, but the following case, related by my friend, Dr. Clutterbuck, proves that gases are sometimes employed. A lady, who had suffered a considerable time from some uterine affection, and had derived no relief from the treatment adopted, was advised to consult a physician in Italy (Dr. Rossi). After he had examined the condition of the uterus, he assured her there was no organic disease, but merely a considerable degree of irritation; for which he proposed to apply Carbonic Acid, as a sedative. This was done by means of a pipe and tube, communicating with a gasometer situated in another room. The patient obtained immediate relief, and although she had been obliged to be carried to the doctor's house, on account of the pain experienced in walking, she left it in perfect ease. On her return to England she had a relapse of the complaint, and applied to Dr. Clutterbuck to know whether she could have the same remedy applied in London, in order to save her the necessity of returning to Italy.

3. *Applications to the Serous Membranes.*

a. Tunica vaginalis. — Irritating injections, such as Wine and Water, solutions of Metallic Salts, &c. are thrown into the cavity of the serous membrane of the testicle in hydrocele, in order to excite inflammation and the subsequent adhesion of the sides of the sac.

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[d] *Edinburgh Medical and Surgical Journal*, vol. xvi.

b. Peritoneum.—Injections have also been made into the peritoneal sac in ascites, and in some cases with success[e]. The practice, however, is very dangerous. Mr. Cooper[f] has seen two fatal cases of it.

4. *Applications to Ulcers, Wounds, and Abscesses.*

These are employed principally to excite local effects, and sometimes, though rarely, to produce a constitutional affection. Thus it has been proposed to apply Corrosive Sublimate to wounds, with the view of causing salivation.

5. *Injection of Medicines into the Veins.*

(Chirurgia infusoria; Ars clysmatica nova; Infusion of medicines.)

This history of this operation is inseparably connected with that of *Transfusion.* The first experiments on infusion are said to have been performed in Germany[g]. But the first scientific examination of the operation was made by Sir Christopher Wren[h]. His example was followed by Boyle, Clarke, Henshaw, Lower, and others[i].

The partisans of this method of treatment assert, that when medicines are administered by the stomach, their properties are more or less altered by the digestive powers of this viscus; and that by injecting medicines at once into the veins, we avoid this influence. This statement, however, is not accurate, since Drs. Christison and Coindet have shewn that some substances are decomposed even in the blood, or at least that they cannot be recognized in this fluid. Furthermore, it has been proved that the effects are of the same general nature as when medicines are applied to the skin or stomach: thus, Tartar Emetic occasions vomiting, Senna purges, Opium stupifies, and so on. So that some of the supposed advantages of this operation have no real existence, while several objections to it exist: such as the danger of introducing air into the veins, or of throwing in too large a dose of the remedy (for a slight excess in some cases may prove fatal), or of the occurrence of phlebitis. These, then, are sufficient reasons for not resorting to this practice, except on very urgent occasions; for example, to excite speedy vomiting when the patient is unable to swallow. Köhler (mentioned by Dieffenbach, who notices also several other analogous cases) preserved the life of a soldier, in whose throat a piece of beef tendon was sticking, by throwing a solution of six grains of Tartar Emetic into a vein of the arm: vomiting was induced, and the meat expelled. Meckel injected two grains of this salt, dissolved in water, into the veins of a woman, to restore suspended animation, from immersion in water. Lastly, cold water has been injected into the umbilical vein in cases of retained placenta[k].

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[e] *Philosophical Transactions* for the year 1744.

[f] *Dictionary of Practical Surgery,* art. *Paracentesis.*

[g] See Paul Scheel's work, entitled "*Die Transfusion des Bluts und Einsprützung der Arzneyen in die Adern,*" Kopenhagen, 1802: Zweiter Band, 1803.

[h] *Philosophical Transactions* for 1665, vol. i. p. 131.

[i] For further information on the history of this operation, consult Scheel's work, before quoted; also Dieffenbach's essay, "*Ueber die Transfusion des Bluts und die Infusion der Arznein,* 1833; or Marx's "*Die Lehre von den Giften,*" 1827 and 1829.

In some obstinate and dangerous diseases this operation is admissible as a last resource; for example, in cases of poisoning, in hydrophobia, in malignant cholera, &c. As plethora appears to diminish absorption, it has been proposed to throw Tepid Water into the venous system in cases of narcotic poisoning, and thus to cause artificial plethora, in order to prevent the occurrence of the symptoms of poisoning by stopping absorption. Vernière found three grains of nux vomica produced no effect when applied to a wound in a dog into whose veins water had been thrown; and he asserts, that by the early use of aqueous injections we may prevent the development of contagious diseases. Magendie has tried the effects of injecting tepid water into the veins in hydrophobia. The operation was first performed at the Hôtel-Dieu, at Paris, in October, 1823: the convulsions were stopped, but the patient died in a day or two afterwards. This operation has been several times repeated, and with the same results. In June 1832, I tried it on a patient (afflicted with this terrible disease) under the care of the late Mr. Bennett, of the Commercial Road: the patient was a boy about nine years of age; he was nearly insensible at the time I performed the operation. I threw in about one quart of tepid water without any obvious effect on the pulse: no convulsions were subsequently observed, but the patient died in a few hours. Saline solutions were injected into the veins in malignant cholera, and often with apparent advantage. Purgatives, Narcotics, &c. have been thrown into the veins by different physiologists, and in most cases the effects observed were similar to, though more powerful than, those produced when these agents were administered by the stomach. To this statement, however, the Oils are an exception; for when injected into the veins in large quantities they interrupt the circulation, and produce a kind of asphyxia.

CHAPTER XI.—ON PHARMACOLOGICAL CLASSIFICATION.

In some works on Medical Botany, which contain figures of the plants employed in medicine, the authors have not followed any arrangement; in consequence, I presume, of the impossibility of procuring specimens in regular order. This is the case in the following works:—

W. Woodville, M.D. Medical Botany, 3 vols. 4to. London, 1790. A Supplement to the Medical Botany, 4to. London, 1794. [In the second edition of this work, published in 1810, the subjects were arranged according to their natural orders.—The third edition, in 1832, by Dr. Hooker and Mr. Spratt, was, in fact, the second edition with a new title and an additional volume].

J. Bigelow, M.D. American Medical Botany, 3 vols. 8vo. Boston, 1817-18-20.

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[k] *Brit. and For. Med. Rev.*, Jan. 1837, and Jan. 1838.

W. P. C. Barton, M.D. Vegetable Materia Medica of the United States, 2 vols. 4to. Philadelphia, 1818.

J. Stephenson, M.D. and *J. M. Churchill*, Medical Botany, 4 vols. 8vo. London, 1827-31.—2nd ed. in 3 vols., by G. Burnett, 1834-36.

Flora Medica, 2 vols. 8vo. 1827.

The large number of substances employed in the treatment of diseases renders some arrangement of them almost absolutely necessary;—and I conceive any order of treating of them to be better than none.

Arrangements or classifications of medicines, like those of plants[1], may be divided into *empirical* and *rational* ones.

1. Empirical Arrangements.

These are independent of the nature of, and have no real relation or connection with, the substances to be arranged. An *alphabetical* order, since it is founded on names which are arbitrary, and have no relation to the bodies they are intended to designate, is of this kind. Two advantages have been supposed to be gained by its employment; firstly, a ready reference to any particular substance; and, secondly, the avoidance of errors committed by writers who adopt other methods. But the first is more imaginary than real; for an index gives to any mode of classification every advantage derived from an alphabetical arrangement; and, as each substance is known by a variety of names, an index becomes as necessary to an alphabetical, as to any other method. Like other classifications this has its disadvantages, the most important of which are, that it brings together substances of the most incongruous natures, and separates those which agree in most of their properties; and from its want of order, it distracts the attention of the student, and is, therefore, totally unfitted for an elementary work.

The following are some of the more important works in which medicines are described in an alphabetical order:—

M. de la Beyrie and *M. Goulin*, Dictionnaire raisonné-universel de Matière Médicale, t. viii. Paris, 1773.

J. Rutty, Mat. Medica antiqua et nova, repurgata et illustrata. 4to. Roterodami, 1775.

W. Lewis, an Experimental History of the Materia Medica, 4to. 1761.—4th edit. by Dr. Aikin, 2 vols. 8vo. 1791.

Andrew Duncan, jun. M.D. The Edinburgh New Dispensatory, 11th ed. Edinburgh, 1826. Supplement to the above, 1829.

J. R. Coxe, M.D. The American Dispensatory. Philadelphia, 1806.

J. Thacher, M.D. The American New Dispensatory. Boston, 1810. 2d edit. 1813.

A. T. Thomson, M.D. The London Dispensatory. London, 1811. 9th ed. 1837.

J. A. Paris, M.D. Pharmacologia, 3rd ed. 1820. 8th edit. 1833. App. 1838.

W. Ainslie, M.D. Materia Indica, 2 vols. London, 1826.

W. T. Brande, A Manual of Pharmacy. London, 1825. 3rd ed. 1833.

A. Chevallier, *A. Richard*, and *J. A. Guillemin*, Dictionnaire des Drogues simples et composées; tom. v. Paris, 1827-9.

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[1] *Théorie Elémentaire de la Botanique*, par A. P. Decandol Paris, 1819.

F. P. Dulk, Die Preussische Pharmakopöe, übersetzt und erläutert; 2te Aufl. 2 Th. 8vo. Leipsig, 1830.

L. Martinet, Manuel de Thérapeutique et de Matière Médicale. Paris, 1828.

F. S. Ratier, Traité élémentaire de Matière Médicale; tom. ii. Paris, 1829.

F. V. Mérat et *A. J. De Lens*, Dictionnaire universel de Matière Médicale et de Thérapeutique Générale, t. vi. 1829-34.

L. W. Sachs and *F. P. Dulk*, Handwörterbuch der praktischen Arzneimittellehre. Königsberg, 1830-37. 19 Lief. A.—St.

G. B. Wood, M.D. and *F. Bache*, M.D. The Dispensatory of the United States of America, 1833. 3rd edit. 1836.

Bachmann, W. L. Handwörterbuch der praktischen Apothekerkunst, 2 Bde. Nürnberg, 1837.

J. Steggall, M.D. A Text Book of Materia Medica and Therapeutics, 12mo. London, 1837.

A. Ure, M.D. A Practical Compendium of the Materia Medica, with numerous Formulæ for the Treatment of Diseases of Infancy and Childhood. London, 1838.

E. Winkler, Vollständiges Real Lexicon der medicinisch-pharmaceutischen Naturgeschicte und Rohwaarenkunde. Heft 1-7. 8vo. Leipzig, 1838-40.

W. T. Brande. A Dictionary of Materia Medica and Practical Pharmacy. 8vo. Lond. 1839.

2. RATIONAL ARRANGEMENTS.

These have an actual relation with the bodies for which they are used, and are the classifications, properly so called. They are founded on the properties of the substances treated of; consequently are as numerous as there are classes of properties. Thus medicines may be arranged according to their

α. Sensible properties (colour, taste, and smell).
β. Natural-historical properties (external form and structure).
γ. Chemical properties.
δ. Physiological effects.
ε. Therapeutical properties.

α. *CLASSIFICATIONS FOUNDED ON THE SENSIBLE QUALITIES.*

Classifications founded on the Colour, Taste, and Odour of plants are necessarily very imperfect, owing to the impossibility of defining sensations. Moreover, their use is very limited, in consequence of these properties having no necessary relation to the medicinal powers[m]. In the best executed arrangements of this kind, the denominations of many of the classes, or orders, are objectionable;—dissimilar bodies are brought together, and similar ones separated.

The following writers have offered the best examples of this mode of classification:—

Jon. Osborne, M.D. On the Indications afforded by the Sensible Qualities of Plants with respect to their Medical Properties. Contained in the Transactions of the Association of Fellows and Licentiates of the King's and Queen's College of Physicians, vol. v. 1828.

A. F. A. Greeves. An Essay on the Varieties and Distinctions of Tastes and Smells, and on the Arrangement of the Materia Medica. [Published by *Dr. Duncan*, in his Supplement to the Edinburgh New Dispensatory. 1829].

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[m] See p. 93.

MR. GREEVES' CLASSIFICATION.

CLASSES.	FAMILIES.	ORDERS.	EXAMPLES.
I. Inodorous and insipid	1. *Liquid*	1.	Water.
	2. *Soft*	1. Pulverescent	Creta.
		2. Unctuous	White Wax.
	3. *Hard*	1. Tough	Iron.
		2. Brittle	Antimony.
II. Inodorous and sapid	1. *Sweets*	1. Saccharine	Sugar.
		2. Amylaceous	Starch.
		3. Mucous or Unctuous	Gum.
		4. Faint	Castor oil.
		5. Frugous	Tamarinds.
	2. *Bitters*	1. Mawkish	Elaterium.
		2. Astringent	Catechu and Alum.
		3. Pure bitter	Quassia.
		4. Austere	Galls.
		5. Styptic	Sulphate of Copper.
		6. Acrid	Colchicum.
		7. Salino-amare	Nitre.
	3. *Alkalines*	1.	Potash.
	4. *Acids*	1. Pure acid	Citric Acid.
		2. Saccharo-acid	Orange juice.
	5. *Salines*	1. Pure salt	Common Salt.
III. Odorous and insipid	1. *Fragrant*	1. Sweet	Yellow Wax.
		2. Aromatic	Saunder's Wood.
IV. Odorous and sapid	1. *Sweets*	1. Saccharine	Honey.
		2. Faint	Senna.
		3. Sweet-spicy	Caraway.
	2. *Bitters*	1. Mawkish	Jalap.
		2. Subastringent	Rhubarb.
		3. Bitter-spicy	Cascarilla.
		4. Sharp-bitter	Aloes.
		5. Austere	Cinchona.
		6. Subacrid	Ipecacuanha and Musk.
		7. Acrid	Copaiba.
	3. *Acidous*	1.	Acetum.
	4. *Camphreous*	1. Camphreous aromatics	Cloves.
		2. Savoury	Pepper.
		3. Terebinthinate	Turpentine.
		4. Camphreous	Camphor.
	5. *Spirituous*	1. Vinous	Wine.
		2.	Alcohol.

β. *CLASSIFICATIONS FOUNDED ON NATURAL-HISTORICAL PROPERTIES.*

By natural-historical properties, I mean those made use of in natural history. They are principally external form and structure. In living beings we find that peculiar structure denominated *organised.* The structure called *crystalline* is peculiar to mineral and other inorganized bodies.

1. *Of Vegetables.*

In the following works the *vegetable* substances employed in medicine are arranged according to their natural-historical properties:—

J. A. Murray, Apparatus Medicaminum tam simplicium quam præparatorum et compositorum, vol. v. Göttingæ, 1776-89:—post mortem auctor. edid. *L. C. Althof*, vol. vi. Göttingæ, 1792.

A. P. De Candolle, Essai sur les Propriétés Médicales des Plantes, comparées avec leurs Formes Extérieurs et leur Classification Naturelle, 1804, 2d éd. Paris, 1816.

A. Richard, Botanique Médicale. Paris, 1823.

P. J. Smyttère, Phytologie-pharmaceutique et Médicale. Paris, 1829.

J. H. Dierbach, Abhandlung über die Arzneikräfte der Pflanzen verglichen mit ihrer structur und ihren chemischen Bestandtheilen. Lemgo, 1831.

T. F. L. Nees von Esenbeck und *C. N. Ebermaier*, Handbuch der medicinisch-pharmaceutischen Botanik. Düsseldorf, 3 Th. 1830-32.

2. *Of Animals.*

The *animal* substances used in medicine are arranged in natural-historical order in the following works :—

J. F. Brandt und *J. T. C. Ratzeburg,* Medizinische Zoologie oder, getreue Darstellung und Beschreibung der Thiere, die in der Arzneimittellehre in Betracht kommen in systematischer Folge herausgegeben. Berlin, 2 B^{de}. 1827-33.

P. L. Geiger, Handbuch der Pharmacie, 2ten B^{d}. 2te H^{te}. Heidelberg, 1829.

John Stephenson, M.D., Medical Zoology and Mineralogy. Lond. 1832.

Dr. T. W. C. Martius, Lehrbuch der pharmaceutischen Zoologie. Stuttgart, 1838.

3. *Of Vegetables and Animals.*

Both the *vegetable* and *animal* materia medica are arranged according to the natural system in the following works :—

J. J. Virey, Histoire Naturelle des Médicamens. Paris, 1820.

A. L. A. Fée, Cours d'Histoire Naturelle pharmaceutique, t. ii. Paris, 1828.

A. Richard, Elémens d'Histoire Naturelle Médicale, t. iii. Paris, 1831-35.

J. Johnstone, M.D. A Therapeutic Arrangement and Syllabus of Materia Medica. 12mo. London, 1835.

E. Soubeiran, Nouveau Traité de Pharmacie théorique et pratique, t. ii. Paris, 1836. 2nde éd. 1840.

As in the subsequent part of this work the vegetable and animal substances used in medicine will be arranged in natural-historical order, it will be unnecessary here to offer any examples illustrative of it. I have preferred this mode of arrangement principally on account of the great difficulties attending any other method, especially that founded on the effects of medicines.

4. *Minerals.*

I am unacquainted with any natural-historical arrangement of the inorganised substances of the matera medica; that is, of an arrangement founded on the external forms and structure of these bodies. Most writers who have followed the natural system in their descriptions of vegetable and animal medicines, have adopted a chemical classification for the inorganised medicinal substances; a mode of proceeding which I shall follow in this work. In the following works on minerals a natural-historical classification is adopted :—

F. Mohs, Treatise on Mineralogy, translated by W. Haidinger. 3 vols. Edinburgh, 1825.

Robert Allan, Manual of Mineralogy. Edinb. 1834.

Modern crystallographers[n] arrange crystalline forms in six groups called

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[n] For further details the reader is referred to the following works :—

1. *Elemente der krystallographie, nebst einer tabellarischen Uebersicht der Mineralien nach den krystallformen,* von Gustav Rose. Zweite Auflage. Berlin, 1838. [A French translation of the first edition was published in Paris, 1834.]
2. *A Treatise on Crystallography,* by W. H. Miller, M.A. F.R.S. &c. Cambridge, 1839.
3. *A System of Crystallography, with its application to Mineralogy,* by John Joseph Griffin. Glasgow, 1841.
4. *Encyclopædia Metropolitana,* art. *Crystallography,* by Mr. Brooke.
5. *Tabelle über die natüralichen Abtheilungen derverschiedenen Crystallizationssysteme.* Nach Prof. C. S. Weiss, für Vorlesungen zusammengestellt und durch Figuren erläutert von Dr. J. T. C. Ratzeburg.
6. *Le Règne Minéral ramené aux Méthodes de l'Histoire Naturelle,* par L. A. Necker, tome 2. Paris, 1835.

systems, each of which comprehends all those forms having axes equal in number, in length, and in direction. These six systems may be conveniently arranged in two classes.

CLASSIFICATION OF CRYSTALS.

CLASS I.

Characters. — *Geometric;* Three rectangular and equal axes. *Optical;* Refraction single. *Thermotic;* Expansion by heat equal in all directions.

☞ As the refraction of this class is single, the crystals present no rings when tested by polarised light.

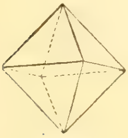
SYSTEM 1.—THE REGULAR SYSTEM.

(Tessular System, *Mohs:* Octohedral System, *Miller.* Tetrahedric, Cubic, Equal-membered, or Equal-axed System).

Characters.—Those of the class.

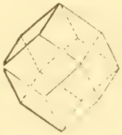
Forms.—The homohedral forms of this system are seven; namely, the *Regular Octohedron,* the *Hexahedron* or *Cube*, the *Dodecahedron*, the *Ikositetrahedron,* the *Triakisoctohedron*, the *Tetrakishexahedron*, and the *Hexakisoctohedron.* The hemihedral forms are five; namely, the *Hemioctohedron* or *Tetrahedron,* the *Hemi-ikositetrahedron* or *Pyramidal Tetrahedron*, the *Hemitriakisoctohedron*, the *Hemihexakisoctohedron*, and the *Hemitetrakishexadron.*

Fig. 22.



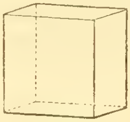
Octohedron.

Fig. 23.



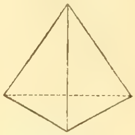
Dodecahedron.

Fig. 24.



Cube.

Fig. 25.



Hemioctohedron or Tetrahedron.

Examples.—The following substances belong to this system:—

Bismuth.
Copper.
Gold.
Iron.
Lead.
Mercury.
Platinum.
Silver.
Diamond.
Phosphorus.
Sal Ammoniac.
Chloride of Sodium.
Chloride of Silver.
Bromide of Potassium.
Iodide of Potassium.
Arsenious Acid.
Alum.

CLASS II.

Characters.—*Geometric;* Not three rectangular and equal axes. *Optical;* Refraction double. *Thermotic;* Expansion not equal in all directions.

☞ As the refraction of this class is double, the crystals present, in certain directions, rings when tested by polarized light.

SYSTEM 2.—SQUARE PRISMATIC SYSTEM.

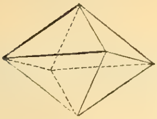
(Pyramidal System, *Mohs*, and *Miller.* The 2- and 1-axed System, *Rose.* The 4-membered System.)

Characters.—*Geometric;* Axes three, rectangular; only two equal. *Optical;* Refraction double in all directions except one, (one axis of double refraction). *Thermotic;* Expansion equal in two rectangular directions; but unequal to these in the third rectangular direction.

☞ As the crystals of this class have only one axis of double refraction, they present a single system of rings, intersected by a cross, when tested by polarized light. (See figs. 29 & 30).

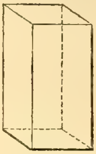
FORMS.—To this system belong the *Octahedron with a Square base*, and the *[Right] Square Prism.*

FIG. 26.



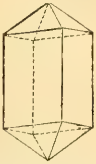
Square Octohedron.

FIG. 27.



Square Prism.

FIG. 28.



Combination of the Octohedron and Prism.

EXAMPLES.—The following substances belong to this system:—

Calomel. | Bicyanide of Mercury. | Ferrocyanide of Potassium.

SYSTEM 3.—RHOMBOHEDRIC SYSTEM.

(Rhombohedral System, *Miller*. The 3- and 1-axed System, *Rose.*)

CHARACTERS.—*Geometric;* Axes four; three equal to one another, and placed in one plane, crossing at angles of 60°; the fourth axis differs from the others in length, and is placed perpendicular to all of them. *Optical;* Refraction double in all directions except one, (one axis of double refraction). *Thermotic;* Expansion equal in the directions of the three equal axes, but unequal to that of those in the direction of the fourth axis.

☞ As the crystals of this system, like those of the preceding system, have only one axis of double refraction, they present a single system of rings, intersected by a cross, when tested by polarised light, as in Calcareous Spar. (See figs. 29 and 30).

Single system of rings seen by looking through a slice of Calcareous Spar (cut perpendicular to the axis of the crystal) placed between two plates of Tourmaline (cut parallel to the axis of the crystal).

FIG. 29.

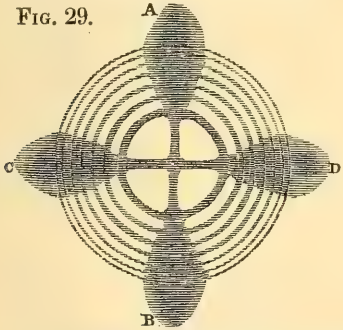


FIG. 30.

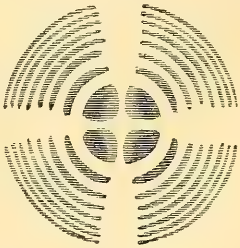


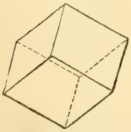
Fig. 29 is seen when the plane of the axis of the Calcareous Spar is parallel or perpendicular to the plane of polarization.

A, B, C, and D, are the arms of the black cross.

Fig. 30 is seen when the Calcareous Spar is turned 45° to the preceding positions.

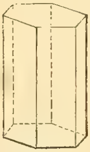
FORMS.—To this system belong the *Hexagondodecahedron*, the *Rhombohedron* (frequently called a Rhomboid) or *Hemidodecahedron*, the *Hexagonal Prism*, and the *Hemididodecahedron* or *Scalenohedron.*

FIG. 31.



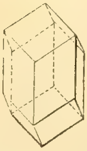
Rhombohedron.

FIG. 32.



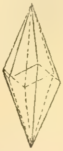
Hexagonal Prism.

FIG. 33.



Combination of the Rhombohedron with the Hexagonal Prism.

FIG. 34.



Scalenohedron.

Examples.—The following substances belong to this system :—

Antimony.
Arsenicum.
Plumbago.
Ice.
Cinnabar.
Chloride of Calcium.
Calcareous Spar.
Carbonate of Iron.
Carbonate of Zinc.
Dolomite.
Nitrate of Soda.
Hydrate of Magnesia.

SYSTEM 4.—RIGHT PRISMATIC SYSTEM.

(Prismatic System, *Miller*. The 1-&-1-axed System, *Rose*.—The 2-&-2-membered System).

Characters.—*Geometric*; Axes three, rectangular, all of different lengths. *Optical;* Refraction double in all directions except two (two axes of double refraction). *Thermotic;* Expansion relatively unequal in the directions of all the axes.

☞ As the crystals of this system have two axes of double refraction, a double system of rings, intersected by bands, is seen when they are tested by polarised light. (See figs. 35 and 36).

Double system of rings seen by looking through a slice of Nitre (cut perpendicularly to the axis of the crystal) placed between two plates of Tourmaline (cut parallel to the axis of the crystal).

Fig. 35.

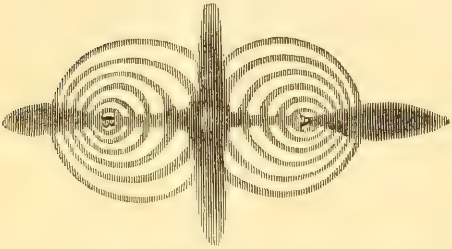


Fig. 36.

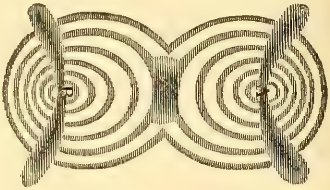
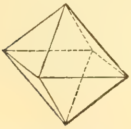


Fig. 35 is seen when the plane of the axis of Nitre is parallel or perpendicular to the plane of polarization.—Fig. 36 is seen when the Nitre is turned 45° to either of these planes.

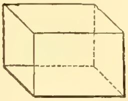
Forms.—To this system belong the *Octohedron with a Rectangular base*, the *Right Rectangular Prism*, the *Octohedron with a Rhombic base*, and the *Right Rhombic Prism.*

Fig. 37.



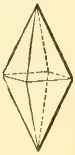
Octohedron with a Rectangular base.

Fig. 38.



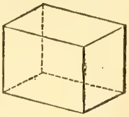
Right Rectangular Prism.

Fig. 39.



Octohedron with a Rhombic base.

Fig. 40.



Right Rhombic Prism.

Examples.—The following substances belong to this system ;—

Iodine.
Sulphur (native).
Pyrolusite (Binoxide of Manganese).
White Antimony (Sesquioxide).
Bichloride of Mercury.
Chloride of Barium.
Sesquisulphuret of Antimony.
Orpiment.
Carbonate of Lead.
Carbonate of Baryta.
Carbonate of Ammonia.
Arragonite.
Sulphate of Potash.
Sulphate of Magnesia.
Sulphate of Zinc.
Sulphate of Baryta.
Sulphate of Strontian.
Bisulphate of Potash.
Nitrate of Silver.
Nitrate of Potash.
Bitartrate of Potash.
Rochelle Salt.
Emetic Tartar.
Citric Acid.
Morphia.

SYSTEM 5.—OBLIQUE PRISMATIC SYSTEM.

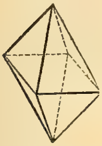
(The 2-&-1-membered System, *Rose*).

Characters.—*Geometric;* Axes three, all unequal; two of them cut one another obliquely, and are perpendicular to the third. *Optical;* Refraction double in all directions except two (two axes of double refraction). *Thermotic;* Expansion, in the direction of the axes, relatively unequal.

☞ As the crystals of this, like those of the preceding system, have two axes of double refraction, a double system of rings, intersected by bands, is seen, when they are tested by polarized light.

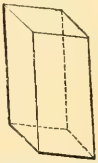
FORMS.—To this system belong the *Oblique Octohedron with a Rectangular base*, the *Oblique Rectangular Prism*, the *Oblique Octohedron with a Rhombic base*, and the *Oblique Rhombic Prism*. Mr. Brooke[°] refers the *Right Oblique-angled Prism* to this group.

FIG. 41.



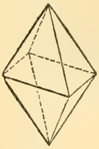
Oblique Octohedron with a Rectangular base.

FIG. 42.



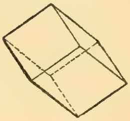
Oblique Rectangular Prism.

FIG. 43.



Oblique Octohedron with a Rhombic base.

FIG. 44.



Oblique Rhombic Prism.

EXAMPLES.—The following substances belong to this system:—

Sulphur (by slow cooling).
Realgar.
Red Antimony.
Carbonate of Soda.
Trona (Sesquicarbonate of Soda).
Bicarbonate of Potash.
Sulphate of Soda.
Sulphate of Iron.
Sulphate of Lime.
Chlorate of Potash.
Phosphate of Soda.
Borax (Tincal).
Acetate of Soda.
Acetate of Copper.
Acetate of Zinc.
Acetate of Lead.
Binacetate of Copper.
Tartaric Acid.
Oxalic Acid.
Sugar.
Crystals from Oil of Cubebs.

SYSTEM 6.—DOUBLY-OBLIQUE PRISMATIC SYSTEM.

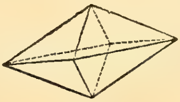
(The 1-&-1-membered System, *Rose*).

CHARACTERISTICS.—*Geometric;* Axes three, all unequal, and oblique-angular to one another. *Optical;* Refraction double in all directions except two (two axes of double refraction). *Thermotic;* Expansion in the direction of the axes relatively unequal.

☞ The crystals of this system present a double system of rings, intersected by bands, when they are tested by polarized light.

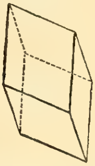
FORMS.—To this system belong the *Doubly-Oblique Octohedron* and the *Doubly Oblique Prism*.

FIG. 45.



Doubly-Oblique Octohedron.

FIG. 46.



Doubly-Oblique Prism.

EXAMPLES.—The following substances belong to this system:—

Boracic Acid.
Nitrate of Bismuth.
Sulphate of Copper.
Sulphate of Cinchonia.
Gallic Acid.

1. ARTIFICIAL METHOD OF LINNÆUS.—This appears to me the best place for noticing those pharmacological works in which the Linnæan artificial method of arranging plants is followed.

[°] *Encyclopædia Metropolitana*, art. *Crystallography*.

Car. A. Linné, Materia Medica, ed. 4^{a}. curante *J. C. D. Schrebero.* Lipsiæ et Erlangæ, 1782.

P. J. Bergius, Materia Medica e Regno vegetabili, 2 tom. ed. 2nda. Stockholmiæ, 1782.

P. L. Geiger, Handbuch der Pharmacie, 3^{tte}. Aufl. 2 B^{de}. Heidelberg, 1830.

2. METHODS FOUNDED ON THE PARTS OF ORGANIZED BEINGS EMPLOYED. — In some works the vegetable and animal substances employed in medicine are classified according to the parts used; as barks, roots, seeds, secretions, &c.

R. A. Vogel, Historia Materiæ Medicæ. Ludg. Batav. & Lipsiæ, 1758.

C. Alston, M.D. Lectures on the Materia Medica, 2 vols. London, 1770.

J. C. Ebermaier, M.D. Taschenbuch der Pharmacie. Leipzig, 1809.

N. J. B. G. Guibourt, Histoire abrégée des Drogues simples, 2de éd. Paris, 1826; 3^{me} éd. 1836.

Dr. F. Goebel and Dr. G. Kunze, Pharmaceutische Waarenkunde. Eisenach, 1827-29.

Dr. T. W. C. Martius, Grundriss der Pharmakognosie des Pflanzenreiches. Erlangen, 1832.

γ. *CLASSIFICATIONS FOUNDED ON THE CHEMICAL CONSTITUENTS.*

The difficulties attending the analysis of organized substances present a great obstacle to the formation of a chemical classification. Most of the writers who have attempted an arrangement of this kind are Germans.

Donald Monro, A Treatise on Medical and Pharmaceutical Chymistry, and the Materia Medica, 3 vols. London, 1788.

C. H. Pfaff, System der Materia Medica nach chemischen Principien mit Rücksicht auf. d. sinnl. Merkmale und d. Heilverhältnisse der Arzneimittel. Leipzig, 7 B^{de}, 1808-24.

F. A. C. Gren: Handbuch der Pharmacologie, 3te Aufl. herausgegeben von *Bernhardi* und *Buchholz*, 2 B^{de}. Halle u. Berlin, 1813.

F. G. Voigtels, Vollständ. System der Arzneymittellehre, herausgegeben von *Kühn.* 4 B^{de}. Leipzig, 1816-17.

C. W. Hufeland, Conspectus Materiæ Medicæ, Berolini, 1816, ed. 2. 1820;—ed. 3. 1828.

G. W. Schwartze, Pharmacologische Tabellen, oder systematische Arzneimittellehre in tabellarischer Form. Leipzig, 1819-25. 2 Aufl. fol. 1833.

G. A. Richter, Ausführliche Arzneimittellehre. Handbuch für prakt. Aerzte. 5 B^{de}. u. 1. Suppl. 1826-32.

L. A. Kraus, Wissenschaftliche Uebersicht der gesammten Heilmittellehre. Götting. 1831.

As an example of a chemical classification I shall select Schwartze's, and must refer the reader to the late Dr. Duncan's (jun.) *Edinburgh Dispensatory*, 11th ed. p. 172, for Pfaff's chemical classification of the vegetable materia medica.

SCHWARTZE'S CLASSIFICATION.

Div.
1. Aqua communis
2. Gummosa, mucilaginosa
3. Farinosa, amylacea
4. Gelatinosa
5. Albuminosa
6. Saccharina
7. Pinguia-oleosa

Div.
8. Extractiva amara
9. Adstringentia seu Tannica
10. Ætherea-oleosa
11. Resinosa
12. Narcotica
13. Spirituosa
14. Acida

Div.
15. Alcalina
16. Salina
17. Metallica
18. Corpora simplicia, solida, non metallica
19. Kalia sulphurata
20. Sapones.

It will be observed that the author has not always founded his divisions on the chemical properties of medicines; since some of them refer partly or wholly to the effects produced by these agents on the body. The nomenclature is not always perfect: thus, his seventeenth class is called "Metallica," as if it alone contained metallic substances; whereas divisions fifteen and sixteen also contain them. Again, some of the divisions, for example "Resinosa," contain substances whose effects are most dissimilar; while substances of analogous operation are placed in separate divisions.

δ. *Classifications founded on the Physiological Effects of Medicines.*

As the ultimate object of all our inquiries into the materia medica is to obtain a knowledge of the mode of operation of medical substances, it follows, that the most desirable and useful, because the most practical, classification of these agents, would be that founded on the similarity of their effects. But so many difficulties exist in the way of producing such an arrangement—so much remains yet to be determined with respect to the nature of the modifications impressed on the organised tissues by the influence of medicines—that it must be evident to every one who attentively studies the subject, that in the present state of our knowledge no such classification can be satisfactorily effected.

Physiological classifications are variously formed. Those that I am acquainted with may be reduced to six groups, or classes. Thus, they may be formed:—

1. According to the General Quality of the Effects.
2. According to Brunonian Principles.
3. According to the Doctrine of Contra-Stimulus.
4. According to the Doctrine of Broussais.
5. According to Chemico-Physiological Principles.
6. According to the Part affected.

1. *According to the General Quality of the Effects.*

These arrangements are founded on the *nature*, *quality*, or *general character* of the effects; as in the following works:—

W. Cullen, M.D. Treatise of the Materia Medica. Edinburgh, 1789.

R. Pearson, M.D. A Practical Synopsis of the Materia Alimentaria and Materia Medica. London, 1808.

C. I. A. Schwilgué, Traité de Matière Médicale, 2 tom. Paris, 1818.

J. Arnemann, Chirurgische Arzneimittellehre, 6^{te} Aufl. von A. Kraus. 1818.

J. Arnemann, Praktische Arzneimittellehre, 6^{te} Aufl. von L. A. Kraus. 1819.

T. Young, M.D. An Introduction to Medical Literature, art. Pharmacology, 2d edit. 1823.

J. B. G. Barbier, Traité Elémentaire de Matière Médicale, 2^{nde} éd. 3 tom. Paris, 1824;—4^e éd. 1837.

N. Chapman, M.D. Elements of Therapeutics and Materia Medica, 4th edit. Philadelphia, 1825.

Dr. Nuttall, Lancet, 1825-6, vol. ix. p. 578.

H. M. Edwards, and *P. Vavasseur*, M.D. Manuel de Matière Médicale. Paris, 1826.—English Translation, by Davis, 1831.

C. Sundelin, Handbuch der speciellen Heilmittellehre, 2 B^{de}. 3^{te} Aufl. 1833.

John Murray, M.D. A System of Materia Medica and Pharmacy, 5th edit. Edinburgh, 1828.

A. Duncan, M.D. Physiological Classification of the Materia Medica. In the Supplement to the Edinburgh New Dispensatory, 11th edit. 1829.

J. Wendt, Praktische Materia Medica. Breslau, 1830. 2te Aufl. 1833.

F. Foy, Cours de Pharmacologie, 2 tom. Paris, 1831.

A. T. Thomson, M.D. Elements of Materia Medica and Therapeutics, 2 vols. 1832;—2d ed. in 1 vol. 1835.

E. S. and *K. D. Schroff*, Arzneimittellehre und Receptirkunde. Wien. 1833.

A. Trousseau et H. Pidoux, Traité de Thérapeutique. Paris, 1er tom. 1836; 2nd tom. 1re part. 1837; 2e part. 1839.—2e éd. 1841.

C. G. Mitscherlich, Lehrbuch der Arzneimittellehre. 1re Bd. 1te Abt. Berlin, 1837.

As examples of this kind of classification, I subjoin those of Dr. Duncan and Sundelin:—

DR. DUNCAN'S PHYSIOLOGICAL CLASSIFICATION OF THE MATERIA MEDICA.

External Agents act,		
I. By nourishing the body	ALIMENTA.	
(*a*) Drink	Potus.	
When they act medicinally		Diluentia.
(*b*) Food	Cibi.	
When they act medicinally..		Demulcentia,
II. By evacuation	EVACUANTIA.	
(*a*) By the skin insensibly		Diaphoretica.
——— sensibly		Sudorifica.
(*b*) By the mucous membrane		
Of the nostrils		Errhina.
Of the lungs		Expectorantia.
Of the stomach		Emetica.
Of the intestines		Cathartica.
Of the uterus		Emmenagoga.
(*c*) By glandular secretion		
The kidneys		Diuretica.
The salivary glands		Sialogoga.
III. By exciting the vital powers	STIMULANTIA.	
(*a*) Chiefly of the parts to which they are applied..	TOPICA.	
Applied externally		
Causing redness		Rubefacientia.
——— serous secretion		Vesicantia.
——— purulent secretion		Suppurantia.
Administered internally.		
Condimenta when alimentary		
When acting medicinally		Carminativa.
(*b*) Of the system generally	GENERALIA.	
(*a*) Obscurely, but more durably	PERMANENTIA.	
Producing no immediate obvious effect		Tonica.
Constricting fibres and coagulating fluids		Astringentia.
(*b*) More evidently, but less durably	TRANSITORIA.	
Acting on the organic functions		Calefacientia.
Acting on the mental functions		Inebriantia.
IV. By depressing the vital powers	DEPRIMENTIA.	
Acting on the organic functions		Refrigerantia.
Acting on the mental functions		Narcotica.
V. By chemical influence on the fluids	CHEMICA.	
Acidifying		Acida.
Alkalizing		Alkalina.

A very cursory examination of the substances placed by the author under each of the above classes will satisfy the most superficial observer, that this classification does not, in a large number of instances, effect that which it proposes to do; namely, to arrange together "substances according to the effects which they produce in a state of health." For example, under the head of Diaphoretics and Sudorifics we have Mustard, Copaiva, Opium, Ipecacuanha, Alcohol, Antimony, Ammonia, and Mercury; among Narcotics are Opium, Nux vomica, Foxglove, Saffron, and Colchicum; in the class Sialogogues we have Horseradish, Tobacco, and Mercury. Now, no one will pretend to affirm that the substances thus grouped together operate in an analogous manner on the system, or that their effects are similar.

SUNDELIN'S CLASSIFICATION.

. Agents which lessen Vitality, and which are adapted for an abnormal augmentation of it.

I. *Adynamic Agents adapted for genuine hypersthenia.*
  - *a.* Agents diminishing the blood and fluids.
    1. Blood-letting.
    2. Antiphlogistic Purgatives.
  - *b.* Adynamic agents in a strict sense,—Temperants.
  - *c.* Agents which abstract heat.

II. *Relaxants adapted for abnormal tension of fibres, and for augmented irritability and sensibility.*
  - *a.* Oleaginous substances.
  - *b.* Mucilaginous, Amylaceous, and Albuminous substances.
  - *c.* Saccharine substances.

B. Alterative Agents adapted for an Alteration of Vitality.

I. *Resolvents adapted for an alteration of Vitality from material causes.*
  - *a.* Solvents.
  - *b.* Absorbents.
  - *c.* Liquefacients.
  - *d.* Irritant resolvents.
  - *e.* Strengthening resolvents.
    1. Excitants.
    2. Tonics.

II. *Evacuants adapted for Retentions.*
  - *a.* Emetics.
  - *b.* Purgatives.
  - *c.* Emmenagogues.
  - *d.* Diuretics.
  - *e.* Diaphoretics.
  - *f.* Diaphoretico-diuretics, or the so-called purifiers of the blood.
  - *g.* Cutaneous irritants.
  - *h.* Anthelmintics.

III. *Alteratives adapted for altered Sensibility and Irritability.*
  - *a.* Narcotics adapted for hyperæsthesis and convulsability.
    1. Depressing agents.
    2. Excitants.
    3. Resolvents.
    4. Acrids.
    5. Bitter poisons.
    6. Metallic substances.

C. Agents which augment Vitality, and are adapted for apparently or actually lessened Vitality.

I. *Irritants adapted for torpid debility.*
  - *a.* Resolvents.
  - *b.* Drastics.
  - *c.* Acrids.

II. *Strengthening Agents adapted for true debility.*
  - *a.* Animating, analeptics.
  - *b.* Exciting-animating agents.
  - *c.* Exciting-strengthening agents.
    1. Carminatives.
    2. Aromatic herbs.
    3. Powerful Excitants.
    4. Balsamics.
    5. Irritating Excitants.
    6. Empyreumatic agents.
    7. Spices.
    8. Exciting irritants.
  - *d.* Tonics.
    1. Consolidating agents.
    2. Tonic Bitters.
    3. Astringents.
    4. Antiseptics.
    5. Exciting Tonics.

2. *According to Brunonian Principles.*

Some physicians have classified the articles of the Materia Medica in accordance with *Brunonian principles.* I have already mentioned that Brown regarded all medicines as stimulants; that is, as agents causing excitement. But he supposed some of them to produce less excitement than is requisite for health; and, therefore, to be the remedies for sthenic diathesis: hence they were termed *Debilitating* or *Antisthenic.* On the other hand, some agents give more excitement than suits the healthy state; and are, therefore, the remedies for the asthenic diathesis. These he called *Stimulant* or *Sthenic* [p]. The following pharmacological works are based on Brunonian principles [q]:—

Versuch einer einfachen practischen Arzneimittellehre. Wien. 1797.

Pharmacopœia Browniana, oder Handbuch der einfachsten und wirksamsten Heilmittel, mit klinischen Bemerkungen im Geiste der geläuterten neuen Arzneilehre. Stuttgart, 1798.

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[p] *The Works of Dr. John Brown,* vol. ii. p. 205. 1804.

[q] *Encyclopädisches Wörterbuch der medicinischen Wissenshaften,* 3 Bd. art. *Arzneimittellehre.*

J. S. Frank, Versuch einer theoretisch-praktischen Arzneimittellehre nach den Principien der Erregungstheorie. Erlangen, 1802.

C. F. Oberreich, Umriss einer Arzneimittellehre nach den Grundsätzen der Erregungstheorie. Leipzig, 1803.

J. J. Chortet, Traité de Pharmacologie, basée sur la theorie de Brown. Paris, 1806.

F. Wurzer, Grundriss der Arzneimittellehre. Leipzig, 1808.

J. H. Müller, Handbuch der Lebens-und Arzneimittellehre. Leipzig, 1809.

J. A. Neurohr, Versuch einer einfachen praktischen Arzneimittellehre. Zweite Aufl. Heidelberg, 1811.

K. Schöne, Praktische Arzneimittellehre für Aerzte und Wundärze nach den Grundsätzen der Erregungstheorie. 2 Bde. Berlin, 1815.

3. *According to the Doctrine of Contra-Stimulus.*

I have already[r] given a sketch of this doctrine, as well as an outline of the classification adopted in the following work:—

G. Giacomini, Trattato filosofico-sperimentale dei Soccorsi Terapeutici, 4 vols. 8vo. Padova, 1833-36.

Andral[s], who quotes Fanzago, Tommasini, and Gozzi, says, that the Italians divide medicines into two classes, *dynamics* and *irritants*. The first comprehends those agents which augment or depress excitability,—stimulants and contra-stimulants; the second includes mechanical and chemical agents.

4. *According to the Doctrine of Broussais.*

The followers of Broussais, the founder of what the French denominate the *New Medical Doctrine*, or *Physiological Medicine*, consider all medicines to be either stimulants or debilitants. When a stimulant is applied to the organ affected, it is termed a direct stimulant; but when applied to a part more or less distant from that affected, it is termed a revulsive, or sometimes an indirect debilitant. Hence medicines are divided into *debilitants*, *direct stimulants*, and *revulsives*. This is the plan adopted in the following work:—

L. J. Begin, Traité de Thérapeutique, rédigé d'après les principes de la nouvelle Doctrine Médicale, t. ii. Paris, 1825.

5. *According to Chemico-Physiological Principles.*

Another mode of classifying medicines is on *chemico-physiological principles*; or, to use the phrase of Dr. Osann[t], "on the chemico-therapeutical basis of natural philosophy." This method has been adopted in the following works:—

K. F. Burdach, System der Arzneimittellehre, 1807-9. 3 Bde. 2te Aufl. 1817-19. Leipzig.

C. H. C. Bischoff, Die Lehre von den chemischen Heilmitteln, oder Handbuch der Arzneimittellehre. 3 Bde. 1825-31. Bonn.—[I have given a sketch of this classification in the *London Medical Gazette*, vol. xvii. p. 164.]

W. Grabau, M.D., Chemisch-physiologisches System der Pharmakodynamik. 1er Theil Kiel, 1837. 2er Theil Kiel, 1838.

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[r] See p. 130.

[s] *Dict. de Méd. et de Chirurg. pratiq.* art. *Contre-Stimulant.*

[t] *Encyclop. Wörterb. d. med. Wissenschaften.*

6. *According to the Part affected.*

Another mode of classifying medicines is to arrange them according to the *particular structure or organ which they affect;* as into medicines acting specifically on the nervous system; medicines acting specifically on the vascular system, and so on. Some authors have formed their principal divisions, or classes of medicines, from the parts acted on, and their orders from the nature or quality of the effect. The following writers have founded their classifications on the particular organs affected by medicines:—

J. L. Alibert, Nouveaux Elémens de Thérapeutique et de Matière Médicale, 5^{me} éd. 3 t. Paris, 1826.—[I have given a sketch of this classification in the *London Medical Gazette,* vol. xvii. p. 165.]

Dr. Granville, Medical and Physical Journal, for April, 1822, vol. xlvii.

J. Eberle, M.D., A Treatise on Materia Medica and Therapeutics, 2d ed. Philadelphia, 1824;—3d edit. 1825.

Ph. F. W. Vogt, Lehrbuch der Pharmakodynamik. 2 B^{de} 2te Aufl. 1828;—3te Aufl. 1832.

Dr. Michaelis, Encyclopädisches Wörterbuch der Medicinischen Wissenschaften. Art. Arzneimittel. Berlin, 1829.

EBERLE'S CLASSIFICATION.

A.—Medicines that act specifically on the intestinal canal, or upon morbific matter lodged in it	I. Medicines that excite discharges from the alimentary canal		Emetics. Cathartics.
	II. Medicines calculated to destroy or counteract the influence of morbific substances lodged in the alimentary canal		Anthelmintics. Antacids.
B.—Medicines whose action is principally directed to the muscular system	I. Medicines calculated to correct certain morbid conditions of the system, by acting on the tonicity of the muscular fibre		Tonics.
	II. Medicines calculated to correct certain morbid states of the system, by acting on the contractility of the muscular fibre		Astringents.
C.—Medicines that act specifically on the uterine system	I. Medicines calculated to promote the menstrual discharge		Emmenagogues.
	II. Medicines calculated to increase the parturient efforts of the womb		Abortiva.
D.—Medicines that act specifically on the nervous system	I. Medicines that lessen the sensibility and irritability of the nervous system		Narcotics.
	II. Medicines that increase and equalize the nervous energy		Antispasmodics.
E.—Medicines whose action is principally manifested in the circulatory system	I. Medicines that increase the action of the heart and arteries		Stimulants.
F.—Medicines acting specifically upon the organs of secretion	I. Medicines that act on the cutaneous exhalents	General	Diaphoretics.
		Topical	Epispastics. Errhines. Emollients.
	II. Medicines that increase the action of the urinary organs		Diuretics.
	III. Medicines that alter the state of the urinary secretion		Antilithics.
	IV. Medicines that promote the secretory action of the salivary glands		Sialagogues.
G.—Medicines that act specifically upon the respiratory organs	I. Medicines calculated to increase the mucous secretion in the bronchia, and to promote its discharge		Expectorants. Inhalations.
	II. Medicines whose action is truly topical		Emollients. Escharotics.

VOGT'S CLASSIFICATION.

Vogt makes three classes of medicines: the first including those agents which specially affect the *sensibility* of the body, the second containing those which alter the *irritability* of the system, and the third embracing those agents which influence what he calls the *vegetation* of the body—that is, the organic functions; namely, nutrition and reproduction.

	ORDERS.	DIVISIONS.
Class 1. *Medicines operating specially on the nervous system, and particularly used as nervous agents*	1. Medicines which limit the vital manifestation of the nervous system (*Narcotica*)	1. Opium and its allies. 2. Nux Vomica, and medicines similar to it. 3. Hydrocyanic Acid, and vegetables allied to it. 4. Belladonna, and medicines similar to it.
	2. Medicines which exalt and strengthen the vital manifestations of the nervous system (*Nervina*)..	1. Nervinia volatilia (Ammonia, Musk, &c.) 2. Nervino - alterantia antispasmodica (Ipecacuanha, Copper, Zinc, Bismuth, &c.)
Class 2. *Medicines operating specially on irritable life*	1. Weakening (*Antiphlogistica*), as the Neutral Salts, Cold, &c.	
	2. Medicines which heighten and strengthen the vital manifestations of the irritable system	1. Excitantia volatilia (as Camphor, Mints, &c.) 2. Tonica. 3. Antiseptica (Acids, Chlorine, &c.)
Class 3. *Medicines operating specially on the vegetative* [organic] *system, and which are particularly used in diseases of vegetation* [nutrition and reproduction]..................	1. Medicines operating specially on the secreting and excreting systems..	1. Heat. 2. Gummi-Resinosa, Balsamica, and Resinosa. 3. Resolventia (Acrids, Mercury, Antimony, Sulphur, Alkalis, Iodine, &c.)
	2. Medicines which specially operate on the formative process	1. Aromata (Pepper, Pyrethrum, Nutmegs, &c.) 2. Nutrientia.

ε. *Classifications founded on Therapeutical Properties.*

The curative and remedial powers of medicines are not absolute and constant, but relative and conditional; so that we have no substance which, under every circumstance, is a remedy for a particular disease. This will explain why no modern author has attempted to classify remedies according to their therapeutical properties. Such a classification, if attempted, must be an arrangement of diseases, and an enumeration of the medicines which experience had found frequently, though not invariably, beneficial for each. On this principle, an *Index of Diseases and of Remedies according to the opinions of the ancient Greeks, Latins, and Arabs,* has been given in the following work:—

J. Rutty, M.D. Materia Medica antiqua et nova, repurgata et illustrata, 4to. Rotterodami, 1775.

Strictly speaking, therefore, there are no substances to which the term *Specifics* (*specifica qualitativa,* Hufeland[u]) can be properly applied. Yet it cannot be denied that there are many medicines which are particularly appropriated to the cure of certain diseases, or to the relief of particular symptoms; experience having shown that they more frequently give relief than other agents. As examples I may refer to the use of Mercury in syphilis, Sulphate of Quina in ague, Arsenious Acid in lepra, Sulphur in the itch, and Hydrocyanic Acid in vomiting. Moreover, I cannot admit that any satisfactory explanation has yet been given of the *modus medendi* of many of these agents. The relief obtained in constipation by the use of Senna, and in pain by that of Opium, is explicable by reference to the known physiological effects of these substances.

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[u] *Lehrbuch der allgemeinen Heilkunde,* S. 194. 2te Aufl. Jena, 1830.

But the benefit procured in venereal diseases by Mercury, in ague by Sulphate of Quina, &c. cannot be accounted for by reference to any known physiological effects which these substances produce, and our use of them, therefore, is, at present, empirical. It cannot, however, be doubted that had we a more intimate acquaintance with, and precise knowledge of, the action of remedies, the therapeutical properties of medicines would no longer appear incomprehensible and mysterious.

Though no systematic therapeutical classification has, to my knowledge, been attempted by modern authors, yet in some recent works several therapeutical classes have been admitted; especially in the following:—

F. Foy, M.D. Cours de Pharmacologie. 2 tomes. Paris, 1831.—[His class of Specifics includes Antisyphilitics, Antipsorics, Febrifuges or Antiperiodics, Antiscrofulous medicines, and Anthelmintics].

J. H. Dierbach, M.D. Die neuesten Entdeckungen in der Materia Medica. 2te Ausg. 1er Band. Heidelberg und Leipzig, 1837.

CHAPTER XII.—ON THE PHYSIOLOGICAL CLASSES OF MEDICINES.

I have already (p. 167) expressed my opinion that, in the present state of our knowledge, a physiological classification of medicines cannot be satisfactorily effected. It is principally on this ground that I have thought it advisable, in the following pages, not to follow any attempted arrangement of this kind in describing the substances used in medicine. It, however, appears to me advisable to precede the account of medicines individually, by some notice of the more important groups which they form when arranged on physiological principles.

Medicines may be arranged physiologically on two principles;—according to the parts or organs which they affect, or according to the nature or quality of the action which they set up. But to the exclusive adoption of either principle, obstacles almost insurmountable oppose themselves. These mainly arise from the difficulty experienced in discriminating between the primary and secondary effects of medicines.

In a classification of medicines according to the parts or organs affected, it would be found, I suspect, that four-fifths of our Materia Medica might be placed in one class, under the denomination of medicines affecting the nervous system (cerebral, true spinal, and ganglionic systems[v]); while in a classification strictly founded on the nature or quality of the action which they induce, most of our medicines would belong to the class of alteratives[w].

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[v] See some remarks on the therapeutics of these systems, in Dr. Marshall Hall's work *On the Diseases and Derangements of the Nervous System*, pp. 36, 113, and 129.

[w] Medicines may augment, lessen, or alter vital action. See p. 128.

CLASS 1. MEDICAMENTA CEREBRO-SPINANTIA.—CEREBRO-SPINANTS.

(Narcotics, *Auctorum*).

DEFINITION.—Medicines which produce or prevent sleep, or which affect the intellectual functions, sensation, or the irritability of the muscular fibres, I denominate *Cerebro-spinants*, because they affect the functions of the cerebro-spinal system (cerebral and true spinal systems of Dr. Marshall Hall).

PHYSIOLOGICAL EFFECTS.—The only essential physiological property which these agents possess in common, is that of specifically affecting the cerebro-spinal system. In other respects they present a considerable diversity of operation,—though they are so mutually related that we cannot with propriety place them in separate classes.

Cerebro-spinants differ among themselves with regard to both their topical and remote effects. The *topical* effect of Opium is that of a very slight benumbing agent; Aconite causes numbness and tingling; Conia occasions local paralysis; Tobacco, Foxglove, &c. operate on the alimentary canal as acrids; Alcohol and the Metallic Cerebro-spinants are caustics. In their *remote* effects we observe the same want of uniformity. Alcohol renders the pulse fuller and more frequent; while Foxglove reduces its power and frequency. Opium causes constipation, while Tobacco relaxes the bowels. Lastly, in the modifications occasioned in the functions of the cerebral and spinal system, we observe an equal diversity of operation.

Considered with regard to their effects on the cerebro-spinal system, these agents may be arranged in ten orders, as follows:—

ORDER 1. CONVULSIVES (*Tetanics*). *Agents which augment the irritability of the muscular fibre, and in large doses occasion convulsions.*—This order includes Strychnia, Brucia, and all substances which contain one or both of these alkalis; as Nux Vomica, St. Ignatius's Bean, Snake-wood (*lignum colubrinum*), the *Upas Tieuté*, and probably the Tanghin poison. These agents are principally employed in torpid or paralytic conditions of the muscular system, under regulations which will be pointed out hereafter.

ORDER 2. PARALYSERS. *Agents which cause paralysis of voluntary motion, and lessen the irritability of the muscular fibres.*—This order contains Conia, an alkali procured from Hemlock; and which, considered physiologically, would appear to be the remedy for augmented irritability of the muscles, as in Tetanus and Hydrophobia.

ORDER 3. BENUMBERS. *Agents which cause topical numbness [paralysis of the sentient nerves?] and muscular weakness.*—Monkshood, and its alkali Aconitina, occasion numbness and tingling in the parts to which they are applied. They give rise to a feeling analogous to that produced, on the return of sensation, after the removal of pressure upon a nerve, and which is commonly denominated "pins and needles." When swallowed, they also occasion muscular weakness. As they diminish feeling, they are adapted for the relief of neuralgia.

ORDER 4. CONVULSIVE STUPEFACIENTS, ACTING RAPIDLY AND SUDDENLY, (*Epileptifacients?*) *Agents which cause sudden loss of intellect, sensation, and volition, and usually occasion convulsions.*—This order includes Hydrocyanic Acid, the Cyanides of Potassium and Zinc, Bitter Almonds and their Volatile Oil, and the Cherry-laurel and its Volatile Oil and Distilled Water. The narcotic gases (Carbonic Acid, Sulphuretted Hydrogen, &c.) when inhaled, belong to this order. In celerity of effect, and rapidity with which they prove fatal, no agents exceed, and few equal, the poisons of this order. The sudden loss of sensation and of consciousness, with violent convulsions, which are the characteristic effects of this order, constitute also the essential symptoms of an epileptic paroxysm: they also sometimes occur from the loss of large quantities of blood.

The analogy between these three conditions (*i. e.* hydrocyanic poisoning, epilepsy, and the effect of hemorrhage) is further shewn by the fact that the symptoms of all are relieved by Ammonia. As therapeutical agents, hydrocyanic acid and its allies prove exceedingly useful in certain painful affections of the stomach, unaccompanied by inflammation.

ORDER 5. CONVULSIVES WHICH CAUSE DELIRIUM FOLLOWED BY SLEEP OR STUPOR. *Agents which, in moderate doses, act as cardiaco-vascular stimulants, and exhilirate; in excessive doses cause confusion of head and impaired volition, followed by delirium, convulsions, and insensibility.*—This order was contrived to include Camphor.

ORDER 6. PARALYSING, PUPIL-CONTRACTING STUPEFACIENTS (*Narcotics; Apoplectifacients?*) *Agents which lessen feeling, and the irritability of the muscular fibres, and cause contraction of the pupils, and paralysis of voluntary motion, and sleep or stupor.*—Opium and its alkali Morphia constitute the type of this Order, to which, probably, Lactucarium also belongs. In small doses they usually excite the vascular system, check the mucous secretions of the alimentary canal, and promote sweating. In larger doses they lessen sensation, diminish the irritability of the muscular fibre (when fatal doses have been taken actual paralysis precedes death), cause contraction of the pupils, and occasion sleep or stupor. The apoplectic condition thus induced is denominated *narcotism.* In therapeutics, these agents are used—

a. To check profuse mucous secretion of the gastro-intestinal membrane.
b. To promote sweating.
c. To diminish augmented irritability of the muscular system (spasm or convulsion). When thus used they are termed *antispasmodics.*
d. To relieve pain. In this case they are called *anodynes* (from α, privitive, and ὀδύνη, pain), or *paregorics* (from παρηγορέω, to soothe or alleviate).
e. To procure sleep. When thus used they are denominated *hypnotics* (ὑπνωτικὸς, from ὕπνος, sleep), or *soporifics* (from *sopor*, a deep sleep, and *facio*, I make).

ORDER 7. INEBRIATING, PARALYSING STUPEFACIENTS (*Inebriants; Intoxicants*). *Agents which produce a peculiar disorder of the intellect, called inebriation or intoxication, impair volition, and, when used in excess, occasion paralysis of voluntary motion, and stupor.*—Alcohol, Wine, and Ether, belong to this Order, which is closely allied to the preceding one. The agents composing it are remarkable for their exciting influence over the cardiaco-vascular system, and for the peculiar form of intellectual disorder which they occasion, but which varies somewhat in different persons. By long-continued use, alcohol gives rise to the disease termed *delirium tremens*, which is characterized by wakefulness, delirium, and tremor. The substances of this group are employed in medicine principally as excitants and stimulants.

α. Protoxide of Nitrogen should, perhaps, constitute a subdivision of this order. When inhaled it causes exhilaration, temporary delirium, and blueness of the lips. Stupor is sometimes produced by it.

β. Indian Hemp (*Cannabis indica*) should form either another subdivision, or, perhaps, a distinct order. It causes a very agreeable kind of delirium, augmented appetite, venereal excitement, and impaired volition, followed by insensibility, during which the patient retains any position in which he may be placed. Its effects, therefore, simulate catalepsy [x]. (*Cataleptifacient?*).

ORDER 8. DELIRIFACIENTS [y] WHICH DILATE THE PUPIL AND PARALYSE THE THROAT. *Agents which cause dilatation of pupil, obscurity of vision, dysphagia, aphonia, and delirium, terminating in stupor.*—Belladonna, Stramonium, and Hyoscyamus, belong to this order. They cause dilatation of pupil, obscurity of vision or actual blindness, dryness of the throat, difficulty or entire loss of power of deglutition, aphonia or difficult articulation, weak pulse, fainting, and delirium, followed by sopor or lethargy. Convulsions are not constant. These effects have been compared to the symptoms of hydrophobia. Spasmodic difficulty of breathing, and angina pectoris, have been alleviated by these agents. Belladonna is employed to dilate the pupil, and to allay neuralgic pain.

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[x] *On the Preparations of the Indian Hemp, or Gunjah (Cannabis indica), their Effects on the Animal System in Health, and their Utility in the Treatment of Tetanus and other Convulsive Disorders.* By W. B. O'Shaughnessy, M.D. Calcutta, 1839.

[y] From *delirium* and *facio*, I make.

ORDER 9. NAUSEATING, CARDIACO-VASCULAR SEDATIVES, WHICH OCCASION TREMBLING AND WEAKNESS OF MUSCLES AND CONFUSION OF INTELLECT.—*Agents which produce nausea, sometimes vomiting and purging, weakness and irregularity of pulse, syncope, impaired vision, giddiness, and confusion of ideas. Paralysis, convulsions, delirium, and stupor, are occasional symptoms.* Foxglove and Tobacco belong to this group.

ORDER 10. METALLIC CEREBRO-SPINANTS. *Metallic substances having a local chemical action, and which affect the functions of the true spinal system.*—This order is a very heterogeneous one, and admits of several subdivisions.

α. PLUMBEOUS CEREBRO-SPINANTS. The preparations of Lead occasion colic and paralysis. From their constringing effects on the capillary vessels they have been termed *astringents.*

β. MANGANESIC CEREBRO-SPINANTS.—According to Dr. Coupar[z] they occasion paraplegia without colic or tremor.

γ. MERCURIAL CEREBRO-SPINANTS.—By long-continued use, in small doses, mercurials occasion paralytic tremor (*tremor mercurialis*), and ultimately convulsive agitation of the limbs. (*Choreafacients?*).

δ. ANTISPASMODIC METALLIC CEREBRO-SPINANTS.—This group includes the Preparations of Arsenic, Bismuth, Copper, Silver, and Zinc. Their influence over the true spinal system is shewn by their remedial influence in epilepsy and chorea (whence their denomination of *antispasmodics*), as well as by the cramps or convulsions or paralysis which they occasion when taken in poisonous doses. In small doses they sometimes cure ague and other periodical maladies, and have, in consequence, been termed *tonics.* This group corresponds very nearly to that called by Vogt[a] *nervino-alterantia.* Arsenic, when swallowed in an excessive dose, sometimes occasions narcotism.

LOCALITY AND QUALITY OF THE ACTION OF CEREBRO-SPINANTS.—Those cerebro-spinants which occasion lesions of the mental functions, of sensibility, or of volition, or which prevent or produce sleep, affect the cerebrum or cerebellum.

These lesions put on a great variety of forms. Mania, delirium, inebriation, erroneous perceptions or judgments, and stupor or coma, are morbid conditions of the mental faculties. Pain, numbness, tingling, loss of feeling, spectra, impatience of light, impaired vision, amaurosis, &c. are disordered conditions of sensibility. Paralysis (cerebral) of voluntary motion is a lesion of volition, one of the cerebral functions.

Those cerebro-spinants which either augment or lessen the irritability of muscles, affect the true spinal system.

Spasm or convulsion is the result of an augmentation of the irritability of muscles. If the influence of the true spinal marrow over the muscles be destroyed, the muscles are no longer irritable. This state, which may be denominated spinal paralyis, or paralysis of irritability, must not be confounded with cerebral paralysis, or paralysis of voluntary motion[b].

Mr. Grainger[c] has shown that the centre of the true spinal system is the grey matter of the true medulla oblongata and medulla spinalis. From this centre proceed the incident excitor and the reflex motor nerves.

The affection of either the cerebral or true spinal systems induced by cerebro-spinants, may be primary or secondary; for these two systems are so mutually related, and have such an influence over each other, that if one be disordered, the other readily becomes implicated.

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[z] *British Annals of Medicine,* Jan. 13th, 1837, p. 41.

[a] *Lehrbuch der Pharmakodynamik.* Bd. 1. S. 269. 2te Aufl. Giessen, 1828.

[b] See Dr. Hall's paper on this subject in the *Medico-Chirurg. Trans.* vol. xxii. [vol. iv. N. S.] p. 191.

[c] *Observations on the Structure and Functions of Spinal Cord.* Lond. 1837.

Thus convulsions arise from a lesion of the true spinal system; yet it is well known that they frequently attend diseases of the encephalon. The "cause," observes Dr. Hall, "appears to be either irritation or counter-pressure: the former may act through the medium of the nerves distributed to the membranes,—as the recurrent of the trifacial of Arnold,—as in epilepsy induced by a spicula of bone; the latter is illustrated by the case of meningitis, by Dr. Abercrombie, in which the anterior fontanelle became prominent; pressure upon it induced convulsion[d]." On the other hand, affections of the true spinal system may induce lesion of the cerebral faculties. Thus convulsion may, by stopping respiration, cause coma.

Attempts have been made to localize more precisely the action of cerebro-spinants, but without much success. Thus Flourens[e] says that Opium acts specifically on the cerebral lobes; that Belladonna, in a limited dose, affects the tubercula quadrigemina, and in a larger dose the cerebral lobes also; that Alcohol, in a limited dose, acts exclusively on the cerebellum, but in a larger quantity, it affects also neighbouring parts; and, lastly, that Nux Vomica more particularly affects the medulla oblongata.

It cannot be doubted, that most of the peculiarities which attend the operation of individual cerebro-spinants arise from different parts of the nervous centres being unequally affected by different agents.

Great difficulty attends all attempts made to ascertain the nature of the changes which cerebro-spinants induce in the nervous centres. This arises, in part, from the fact, that similar symptoms attend dissimilar affections of these parts.

Thus *coma* may be induced by compression of the cerebrum, or by loss of blood. *Delirium* may arise from irritation of the cerebrum, or from loss of blood. *Convulsions* may be produced by irritation, or lesion of the medulla oblongata and spinalis, or by loss of blood. *Paralysis* may arise from lesion of the encephalon, destructive injury of the medulla oblongata or spinalis, and loss of blood.

Alterations in the quantity or quality of the blood supplied to the different parts of the cerebral and true spinal systems, are probably the primary causes of the changes which cerebro-spinants induce in the condition of the functions of these systems. By long-continued use of these agents, slight chemical changes may, perhaps, be induced in the nervous tissue (see p. 103).

Augmented arterial action, or venous congestion, sometimes attends the operation of cerebro-spinants. Flourens[f] declares that Opium, Belladonna, Alcohol, and Nux Vomica, give rise to phenomena resembling those which attend mechanical lesions of the parts on which he asserts these agents operate (see above); and furthermore he states, that in birds it is possible to observe, through the cranium, changes of colour [some alterations in the vascular condition of the parts] which these agents effect in the brain.

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[d] *On the Diseases and Derangement of the Nervous System*, p. 97. Lond. 1841.

[e] *Recherches expérimentales sur les Propriétés et les Fonctions du Système Nerveux dans les Animaux vertébrés*, pp. 254, 258, 261, & 262. Paris, 1824.

[f] *Op. cit.*

CAUSE OF DEATH.—In general, the immediate cause of death, in cases of poisoning by the cerebro-spinants, is an impediment to respiration or circulation. Thus, the process of respiration may be stopped by a paralytic or a spasmodic condition of the respiratory muscles, or by closure of the larynx; and the circulation of blood may cease in consequence of paralysis of the heart. These are obvious and readily understood causes of death. But in some cases the cerebro-spinants appear to destroy life in some other way. Thus, Hydrocyanic Acid injected into the veins kills within a few seconds, without stopping the action of the heart, which continues to beat for some minutes after the chest has been laid open. Now in such cases, it appears to me, that the death is too rapid to be fairly ascribable to the stoppage of respiration,—nor can it be referred to cessation of the heart's action.

α. *Paralysis of the muscles of respiration.*—In some cases the respiratory muscles do not receive their proper supply of nervous energy, in consequence of which respiration is performed with increasing difficulty, until, ultimately, asphyxia is produced. The failure of the excito-motor power, in these instances, arises from the action of the poison on the true spinal system[g]. This kind of death is caused by Opium, and sometimes by Diluted Hydrocyanic Acid. If the body be opened immediately after death, the heart is found beating, oftentimes with considerable force, and for some minutes. These are the cases in which it has been proposed to prolong life by artificial respiration until the effect of the poison has passed off. The proposition is not supported merely by its ingeniousness and plausibility, but by experience. The following is a case in point, related by Mr. Whateley, and quoted by Dr. Christison[h]:—A middle-aged man swallowed half an ounce of crude Opium, and soon became lethargic. He was roused from this state by appropriate remedies, and his surgeon left him; but, the poison not having been sufficiently discharged, he fell again into a state of stupor; and when the surgeon returned, he found the face pale, cold, and deadly, the lips black, the eyelids motionless, so as to remain in any position in which they were placed, the pulse very small and irregular, and the respiration quite extinct. The chest was immediately inflated by artificial means; and, when this had been persevered in for seven minutes, expiration became accompanied with a croak, which was gradually increased in strength till natural breathing was established; emetics were then given, and the patient eventually recovered. Another most interesting case of recovery from poisoning by Opium, by artificial respiration, has been detailed by Mr. Howship[i]. I have several times restored animals apparently dead, from the use of Hydrocyanic Acid, merely by keeping up artificial respiration; and Sir Benjamin Brodie has done the same with animals apparently killed by the Oil of Bitter Almonds.

β. *Convulsions or spasm of the respiratory muscles.*—Another cause of death brought on by cerebro-spinants is spasm of the respiratory muscles, whereby the function of the respiration is stopped, and asphyxia produced. In such cases

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[g] Dr. Marshall Hall (*On the Diseases and Derangements of the Nervous System*, p. 63) gives the following

TABLE OF THE SYSTEM OF THE RESPIRATORY NERVES.

I. *The Excitors.*	II. *The Centre.*	III. *The Motors.*
1. The Trifacial,	The Medulla Oblongata.	1. The Spinal Accessory,
2. The Pneumogastric,		2. The Intercostal,
3. The Spinal.		3. The Diaphragmatic,
		4. The Lower Spinal, &c.

[h] *Treatise on Poisons*, p. 680. 3d ed.

[i] *Medico-Chirurgical Transactions*, vol. xx. p. 86.

the reflex action is augmented. We have an example of this mode of operation in death by Strychnia, Brucia, and the substances containing these alkaloids.

γ. *Closure of the larynx.*—When an attempt is made to inspire pure Carbonic Acid, as well as some other gases, the larynx spasmodically closes, and death results from asphyxia. In a case of complete insensibility from intoxication related by Mr. Sampson[k], the comatose state was thought to arise, not from apoplexy, "but from torpor of the brain, in consequence of that organ being imperfectly supplied with blood not duly oxygenated; for the shrill tone and extreme difficulty of respiration shewed the existence of collapse of the glottis, and imperfect transmission of air into the lungs, which might be accounted for by a paralysed state of the eighth pair of nerves and recurrent branches." Tracheotomy was performed, and with complete success: in about half an hour the respiration was regular and easy through the wound[l].

δ. *Paralysis of the heart.*—In some instances the immediate cause of death appears to be paralysis of the heart; for the heart ceases to beat before respiration has stopped,—as when the Alcoholic Extract of Aconite is applied to wounds in dogs. If the chest be opened, the heart does not contract as usual when irritated by a needle. The infusion of Tobacco appears to kill dogs and cats by paralysing the heart. In the case of poisons acting in this way, it has been proposed to stimulate the heart by slight galvanic shocks, in order to avert the fatal termination. Even acupuncture has been advised, if the patient appeared *in articulo mortis.* Bretonneau[m] has repeatedly punctured the brain, heart, lungs, and stomach of young dogs, without the least inconvenience; and Carraro[n] has successfully tried this practice on animals in a state of asphyxia.

ACTIVE PRINCIPLES.—A considerable number of the vegetable cerebro-spinants owe the whole or part of their activity to *an organic alkali.* The cerebro-spinants belonging to the Almond tribe yield *hydrocyanic acid.* Lastly, *volatile oil* is, in some cerebro-spinants, the active principle.

1. ORGANIC OR VEGETABLE ALKALIS; OR THE ALKALOIDS.—These substances are peculiar to vegetables. As the juices of the plants in which they reside are acid, it is evident that the vegetable alkalis must exist in them in the form of salts. The method of extracting them is not uniform; but for the most part they may be procured by boiling the substances containing them in water acidulated with hydrochloric acid, and neutralizing the filtered decoction with ammonia, lime, or magnesia, by which the organic alkali is precipitated, and is to be subsequently purified, which is usually effected by dissolving it repeatedly in alcohol.

Most of the organic alkalis are solid, inodorous, and crystallizable; *e.g.* Morphia and Cinchonia. Some are pulverulent, as Veratria. Conia is liquid at ordinary temperatures, volatile, and highly odorous. All are combustible. They have an alkaline reaction on vegetable colouring matter, and unite with acids to

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[k] *Medico-Chir. Trans.* vol. xx. p. 46.

[l] Dr. Marshall Hall (*op. supra cit.* p. 280) designates this operation as "one of the *most splendid achievements of modern surgery.*" He considers the case to have been one of "paralysis of the pneumo-gastric nerve and of the dilator muscles of the larynx;" and that the same condition occurs, not only in intoxication, but probably in other cases of coma, as in that of apoplexy, of epilepsy, from opium, &c. He gives the following

TABLE OF THE CLOSURE OF THE LARYNX.

I. *The Excitor.*	II. *Centre.*	III. *The Motor.*
The Superior Laryngeal.	The Medulla Oblongata.	The Inferior Laryngeal or Recurrent.

[m] Bayle, *Travaux Thérapeutiques,* t. i. p. 432.

[n] *Expériences sur des animaux asphyxiés et ramenés à la vie par l'acupuncture du cœur,* in Bayle, *op. cit.* t. i. p. 495.

form salts; but their saturating power is very low (*i. e.* their atomic weights are very high). The alkalis with which we are best acquainted are only slightly soluble in water; but, in general, they readily dissolve in boiling alcohol, and some of them separate in a crystalline state from this liquid as it cools. Their taste is for the most part bitter; that of some is also acrid. Tannic acid unites with them to form tannates, which usually are very slightly soluble only in water. Hence the infusion of galls (which contains this acid) is employed for detecting the alkaloids, and as an antidote in poisoning by them. Iodic acid, in excess, precipitates several of them; but is decomposed by Morphia, iodine being set free. Concentrated nitric acid reddens Morphia and Brucia, and gives a yellow tinge to Narcotina; but a green one to Aricina. Bichloride of Mercury precipitates the hydrochlorates of some of these alkaloids, forming, with them, double salts. The sulphates, nitrates, hydrochlorates, and acetates of the alkaloids, are generally soluble in water. Ammonia and Magnesia decompose their solutions, and precipitate the alkaloid. Carbazotic acid causes yellow precipitates with solutions of Quina, Cinchonia, Brucia, Strychnia, Codeia, and Oxycanthina; but not with Morphia, Narcotina, Veratria, Solanina, Conia, and Emetina[o]. If chlorine gas be passed through a solution of Disulphate of Quina, and Ammonia be subsequently added, an emerald-green liquor is obtained. If Morphia, in the place of the Quinia, be similarly treated, a dark-brown colour results[p].

The constituents of all the organic alkalis, are, *carbon*, *hydrogen*, *nitrogen*, and *oxygen*. In each equivalent of the alkali there is only one equivalent of nitrogen.

The organic alkalis operate powerfully on the animal economy. Some of them are energetic cerebro-spinants; as Morphia and Strychnia: some are acrids; as Veratria; while others are tonic, as Quina and Cinchonia.

2. HYDROCYANIC ACID.—The properties of this acid will be described in a subsequent part of this work. Though readily obtained from the bitter almond, and other substances of that tribe, it does not exist in them ready formed; but is produced by the mutual reaction of amygdalin, emulsin, and water.

3. VOLATILE OIL.—The general properties of the volatile oils will be described under the head of Stimulants. Tobacco and Hops owe part of their medicinal properties to volatile oil. Camphor may be regarded as a concrete volatile oil.

CLASS 2. STIMULANTIA.—STIMULANTS.

(Excitants; Incitants; Calefacients.)

DEFINITION.—An agent which increases the vital activity of an organ is termed a *stimulant* (from *stimulus*, a goad or spur), or sometime an *incitant* (from *incito*, to incite or spur on), or *excitant*. Those which, by exciting the nervous and vascular systems, affect all the organs or functions, are termed *general stimulants;* while others, which influence one or two organs only, are called *local stimulants.* Those which excite the parts to which they are applied are denominated *irritants.*

The distinction to be made between the vital stimuli and the medicinal agents called stimulants (special stimuli), has been already pointed out[q].

PHYSIOLOGICAL EFFECTS.—Most stimulants are odorous,—many of them, indeed, powerfully so. Their taste is warm, acrid, and pungent. Swallowed in moderate quantities, they give rise to a sensation of warmth in the stomach, expel gaseous matters, and assist digestion.

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[o] See Mr. Kemp's paper in the *London Medical Gazette* for April 24, 1840.
[p] Dr. Meeson (by mistake printed Roper), in *London Medical Gazette*, vol. xi. p. 320.
[q] See p. 128.

In larger quantities, they excite thirst, and often give rise to nausea or vomiting. Many of them increase the force and frequency of the heart's action, and promote the warmth of the surface of the body.

Stimulants produce their effects through the agency of the nervous system (*i. e.* the true spinal and ganglionic systems) by a reflex action. Many of them become absorbed, and have been recognised in the blood and secretions.

They are closely related to some other classes, especially to cerebro-spinants, tonics, and evacuants. Thus, Alcohol and Ether are, at the same time, stimulant and narcotic; Myrrh, Cascarilla, and the Ferruginous Compounds, possess both stimulant and tonic qualities; lastly, several of the stimulants are sudorific, diuretic, emmenagogue, &c.

The division of stimulants into groups, founded on the parts or organs which they respectively affect, has been already noticed[r]. I shall here arrange them into five orders, founded partly on their chemical properties, and partly on their physiological effects.

ORDER 1. CONDIMENTARY STIMULANTS.—This order contains those stimulants which are employed as condiments. They contain a volatile oil, to which they owe their remedial and condimentary uses. The action of many of them is principally limited to the alimentary tube. They form three sub-orders, or groups, as follows:—

α. This group, called by Dr. Duncan[s] *volatile pungent stimuli*, contains the *alliaceous* and *siliquose stimulants.* The alliaceous stimulants are Garlic, the Onion, and the Leek, which are obtained from the natural order *Liliaceæ.* The siliquose stimulants are Mustard, Horse-radish, Scurvy-grass, and Cardamine, which are procured from *Cruciferæ.* Most of the substances composing this group contain, or yield, an acrid volatile oil (composed of *carbon*, *hydrogen*, *nitrogen*, *oxygen*, and *sulphur*), to which they owe their medicinal qualities. Several of them are employed as condiments. In medicine, we use Mustard as a rubefacient and emetic; Horse-radish as a masticatory; and Garlic as a stimulating expectorant. From their beneficial effects in scurvy, the substances of this group have been denominated *antiscorbutics.*

β. This group contains the *labiate* and *umbelliferous stimulants.* Several of the aromatic plants of the natural order *Labiatæ* are used in cookery as *pot herbs*, or as *sweet* or *savoury herbs;* and the carminative fruit of several Umbelliferous plants are aromatic. Some of the *Compositæ*, as Tansy, are used as pot herbs. Volatile oil is the active principle of the whole group. In the Labiate plants this resides in small receptacles in the leaves; while, in the Umbelliferous fruit, it is contained in clavate vessels, called *vittæ*, situated in the pericarpial coat. Cooks employ some of the substances of this group to form seasoning for certain kinds of dishes or meats. The liqueur-maker uses some of them for flavouring his cordials. In medicine, we employ them principally as flavouring or carminative substances. Thus, they are added to many other medicaments, the unpleasant odour or taste of which they are intended to cover, and whose nauseating properties they check. They are also useful in flatulency, and in spasmodic affections of the alimentary canal, especially the flatulent colic of children.

γ. The third group consists of the substances called *Spices* (*aromata*). These are the products of warm climates, as the Molucca or Spice Islands, Ceylon, the West Indies, &c., and are obtained from the orders *Zingiberaceæ, Lauraceæ, Myrtaceæ, Piperaceæ, Myristaceæ, Solanaceæ*, &c. They owe their strong and grateful odour and taste principally to an acrid volatile oil. When applied to the skin, some of them (as Pepper) act as powerful acrids, and excite local inflammation. Taken internally, in moderate quantities, they stimulate the stomach, create a sensation of warmth in this viscus, and promote digestion and assimilation. In larger quantities, they occasion thirst, increase the fulness of, and accelerate, the pulse, and produce a febrile condition of body. In doses of two drachms, Nutmegs have acted as narcotics.

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[r] See p. 129.

[s] *Supplement to the Edinburgh Dispensatory*, p. 229.

Spices are distinguished from the last group of stimulants by their more agreeable flavour; by their greater acridity; by their less tendency to occasion nausea; and by their more powerful agency in promoting the assimilation of substances reputed difficult of digestion. Both groups, however, yield condiments. (See pp. 10 and 74.)

In medicine they are used as flavouring ingredients, as carminatives, as antispasmodics, and as cordials or stimulants. Thus, they are added to other medicines to correct their nauseous flavour, or their griping qualities. They are given to relieve flatulency and cramp at the stomach; to assist digestion in enfeebled or relaxed habits; to allay griping pains of the bowels, and to check purging in some mild forms of diarrhœa. Some of them (Pepper and Ginger) are applied to the skin as rubefacients, or are chewed as masticatories. Pepper has been successfully employed in intermittents, Cubebs in gonorrhœa. The volatile oil of some of the spices (as of Cloves or All-spice) is occasionally placed in the hollow of a carious tooth to allay tooth-ache.

On account of their acrid and heating properties, spices are objectionable in inflammatory conditions of the alimentary canal, and in febrile conditions of system.

Order 2. Resinous Stimulants.—All the stimulants of this order contain resin. Some (*resins*) of them, indeed, consist almost solely of it. Others (*oleo-resins*) contain also volatile oil. A third group (*balsams*) contains benzoic acid and resin. A fourth group (*gum-resins*) consists of gum, resin, and volatile oil. As these groups differ not only in their chemical composition, but also to a certain extent in their effects and uses, they will require separate examination.

α. Resins (*resinæ*).—Under this head I include Elemi, Mastic, and Guaiacum, obtained, the two first from *Terebinthaceæ*, the last from *Zygophyllaceæ*. They exude either spontaneously or from incisions made in the stems of the plants yielding them. Common resin (called *rosin*) obtained as a residue in the distillation of the Turpentines, may, in regard to its chemical and medicinal qualities, be placed in the same group with the natural resins. The local action of resins is irritant: applied to the skin they produce rubefaction, and when swallowed in large doses, occasion heat of stomach, nausea, vomiting, or even purging. Their constitutional effects are those of stimulants. Thus they occasion thirst, quicken the pulse, raise the temperature of the surface, and promote the secretions, especially of the skin and kidneys. Elemi and Mastic are rarely employed in medicine: their effects are analogous to the Turpentines, but much milder. Guaiacum is used as a stimulant and sudorific.

β. Oleo-resins (*oleo-resinæ; liquid resins; balsams devoid of benzoic acid; terebinthinates*).—These are oleo-resinous, semi-liquid, or glutinous juices, which flow spontaneously, or by incisions, from various vegetables, especially those belonging to the orders *Coniferæ*, *Terebinthaceæ*, and *Leguminosæ*. Their liquidity or semi-liquidity, their odour, and most of their medicinal activity, are owing to the volatile oil which they contain, and which may be procured from them by distillation. From the true balsams they are distinguished by not yielding benzoic acid. They have a strong odour, which, in some, is very fragrant,—in others, so peculiar as to be taken as the type of certain odours under the name of terebinthinate. Those oleo-resins, employed in medicines, are the Turpentines, Copaiva, and Opobalsamum (commonly termed Mecca Balsam). Their taste is hot and acrid. They are all local irritants, causing rubefaction when applied to the skin; some of them giving rise to active inflammation. When swallowed they occasion more or less irritation of the alimentary canal, according to the dose in which they are taken; the symptoms being epigastric heat, loss of appetite, nausea, or even vomiting; and, sometimes, when the quantity swallowed is large, griping or purging. Their constitutional effects are thirst, dryness of the mucous membranes, increased frequency and fulness of pulse, and great heat of skin, frequently accompanied with sweating. They exercise a stimulant influence over the urinary organs, which is manifested by uneasiness in the region of the kidneys, increased desire of passing the urine, heat in the urethra, and sometimes strangury and bloody urine. Under the influence even of small doses the urine acquires a remarkable odour; which, when any of the Turpentines have been taken, is that of violets. The mucous membranes generally are stimulated, and have their secretions diminished by the oleo-resins. By repeated use they sometimes cause a cutaneous eruption. In large doses Oil of Turpentine causes an affection of the nervous system, which will be noticed hereafter.

The oleo-resins are principally employed in medicine to relieve diseases of the mucous membranes, especially the urino-genital mucous membrane. Thus they are employed, and with great benefit, in gonorrhœa, leucorrhœa, gleet, and chronic catarrh of the bladder. In chronic pulmonary catarrhs they are sometimes advantageously employed; but not unfrequently prove injurious, as Dr. Fothergill[t] has shown. Oil of Turpentine has been used in neuralgia, against tapeworm, in puerperal peritonitis, and in other cases to be mentioned hereafter.

γ. *Balsams* (*balsama naturalia: balsams containing benzoic acid*).—The term balsam was formerly applied to all liquid vegetable resins, as well as to many pharmaceutical preparations. But to avoid confusion, the French chemists confine the term balsam to vegetable substances composed of resin and benzoic acid, with more or less volatile oil. But as this would exclude Copaiva and some other substances popularly called balsams, most of the German chemists retain the old acceptation of the term, and divide balsams into those which do, and those which do not, contain this acid.

Balsams (under which term I include those only which contain benzoic acid) are solid, soft, or liquid substances, according to the quantity of volatile oil which they contain: they have an aromatic, usually agreeable, odour, and a warm, acrid taste. They dissolve in alcohol; and the solution, when mixed with water, becomes milky, owing to the deposition of resin. By sublimation, as well as by other methods, they yield benzoic acid. Those employed in medicine are Benzoin, Styrax, Tolu, Peruvian Balsam, and Liquidambar. They are obtained from the orders *Styraceæ*, *Leguminosæ*, and *Balsamaceæ*. They owe the principal part of their medicinal activity to the contained benzoic acid. The liquid balsams (of Styrax and Peru) are sometimes applied to chronic indolent ulcers, to allay pain, to improve the quality of the secreted matter (*detergents*), and to promote cicatrization (*epulotics* or *cicatrisantia*). Taken internally the balsams act as stimulants, their operation being principally directed to the mucous membrane of the air-passages; on this account they are termed expectorants, and are employed in chronic catarrhs. MM. Trousseau and Pidoux[u] assert, from their own experience, that "there are few substances in the materia medica so powerful in combating chronic pulmonary catarrhs and old laryngeal inflammations as the balsams." In chronic inflammation of the larynx, whether accompanied or not by ulceration, balsamic fumigations are more serviceable than the internal exhibition of the balsams. The air of the patient's chamber may be impregnated with balsamic vapours by placing a little Benzoin or Tolu on some live coals, and allowing the vapour to escape into the room: or the patient may inhale the vapour of boiling water to which a drachm or two of the balsams have been added.

δ. *Fœtid* or *antispasmodic gum-resins* (*gummi-resinæ fœtidæ*).—The gum-resins, usually denominated fœtid or antispasmodic, are Asafœtida, Ammoniacum, Galbanum, Sagapenum, and Opoponax, all of which are obtained by incision from plants of the order *Umbelliferæ*, growing, for the most part, in Persia. They are composed principally of gum and resin, but with a small quantity of volatile oil, to which they are mainly indebted for their odour. Rubbed with water, they form a milky fluid or emulsion. They are not completely soluble in pure alcohol, though they form therewith a clear tincture, which becomes milky on the addition of water, by the precipitation of the resin as a white powder. They dissolve, however, in boiling dilute alcohol. They are likewise soluble in vinegar. Their odour is strong and remarkable; their taste warm and acrid.

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[t] *Medical Observations and Inquiries*, vol. iv. p. 231.

[u] *Traité de Thérapeutique*, t. i. p. 467.

Applied to the skin they act as mild stimulants. Taken internally they give rise to a sensation of warmth in the stomach, and cause eructations. The odorous particles of Asafœtida become absorbed, and may be recognised in the blood and secretions. The fœtid gum-resins have been principally, and most successfully, employed in hysteria, flatulent colic, spasmodic asthma, chronic bronchial affections, and in uterine disorders. From their beneficial influence in the first of these diseases, they are inferred to possess a power of specifically affecting the nervous (the true spinal) system. They probably operate by a reflex action.

Myrrh is a gum-resin procured from a plant of the order *Terebinthaceæ.* It does not possess the antispasmodic power of the fœtid gums, but approaches nearer to the tonics.

Olibanum is also a gum-resin, obtained from the same order as myrrh. Its stimulant properties are principally directed to the mucous membranes; and, in this respect, it is analogous to the resins, or rather to the oleo-resins.

ORDER 3. AMMONIACAL, EMPYREUMATIC, and PHOSPHORIC STIMULANTS.—This order contains Ammonia and its salts, the Empyreumatic Oils, Phosphorus, Musk, and Castoreum. It is termed by Vogt[v] *volatile nervines* (*nervinia volatilia*). All the substances of which it is composed agree in producing a primary and specific effect on the nervous system, the energy and activity of whose functions they exalt. According to Vogt[w], the more volatile the remedy the more it increases the *activity* of the nervous functions, and the more fixed the more it raises their *energy.* Thus, according to the same writer, the preparations of ammonia raise the activity more than the energy of these functions; the empyreumatic oils somewhat less; musk still less; while castoreum increases the energy of the functions principally. However, I shall hereafter show that the last-mentioned remedy really possesses very little power.

These remedies act as excitants to the organs of circulation, increasing the force and frequency of the pulse, augmenting the warmth of skin, and promoting diaphoresis. On account of the latter effect they have been termed *diaphoretica calida.*

The effects of the substances composing this group are very quickly produced, and soon disappear. Consequently these remedies are adapted to urgent and acute cases, when the danger is imminent, and an immediate effect desired: for the same reason they require to be frequently repeated, in order to keep up their effects. From their exciting operation, they are indicated in cases of debility and sinking of the vital powers. Thus they are employed in syncope, low fevers, cholera, &c. On account of their specific influence over the nervous system, they are administered in various spasmodic or convulsive diseases, especially in hysteria, and also in epilepsy and chorea.

ORDER 4. CAMPHORACEOUS STIMULANTS.—This order includes Camphor, Serpentary, Contrajerva, Valerian, the Oil of Cajuputi, &c. It corresponds with that division of *volatile excitants* called by Vogt *ætherio-oleosa;* it is a less perfect group than any of those already mentioned. To a certain extent it agrees in its effects with the last-mentioned: thus it specifically stimulates the nervous system, increases the activity of the vascular system, and produces diaphoresis. Its effects, however, are much less powerful, are not so speedily produced, nor are they so fleeting. Some of these (for example, Serpentary and Contrajerva) are serviceable in low nervous fevers; others are used in spasmodic diseases, as Valerian in epilepsy.

ORDER 5. ALCOHOLIC STIMULANTS.—This order is the *spirituosa* of Vogt. It comprehends Alcohol, Wine, and Ether, already mentioned under the head of Cerebro-spinants. Their effects and uses will be fully described in a subsequent part of this work.

ACTIVE PRINCIPLES.—*Volatile oil*, *resin*, and *benzoic acid*, are the active principles of a considerable number of stimulants.

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[v] *Lehrbuch der Pharmakodynamik,* Bd. i. S. 184. 2te Aufl. Giessen, 1828.
[w] *Op. cit.* Bd. i. p. 186.

1. **Volatile Oil** (*oleum volatile*, vel *æthereum*, seu *essentiale*).—Volatile oil is found in both the inorganised and organised kingdoms of nature: it is most common in vegetables. Petroleum and Naphtha are examples of volatile oil in the mineral kingdom. Among animal substances Castoreum may be referred to as containing it. It is found in various parts of vegetables—as in the cortical parts of their stems, in Cinnamon and Cassia; in their rhizomes—as in Ginger and *Acorus Calamus;* in the root—as in Valerian and Horse-radish; in the leaves—as in Buchu, *Labiatæ*, and *Myrtaceæ;* in buds—as in the bulbs of Garlic and Onions; in the flower—as the Rose, Lavender, and Clove; in fruits—as the Orange and *Umbelliferæ;* and sometimes, though very rarely, in the seeds—as in the Nutmeg. From these different parts it is occasionally obtained by pressure, but more commonly by distillation. Thus Oil of Lemons is procured by pressure, Oil of Turpentine by distillation. Several volatile oils are obtained by the decomposition of organic substances. Oil of Bitter Almonds is one of the products of the mutual reaction of amygdalin, emulsin, and water.

The volatile oils may be solid or liquid, at ordinary temperatures; when solid they are crystalline. They may be lighter or heavier than water; their sp. gr. varying from 0·627 to 1·094[x]. They may be coloured or colourless; if the former, the tint is various in different oils. All the essential oils have a strong odour, and a hot acrid taste. They are easily volatilised by heat; are combustible, in consequence of the large quantity of carbon and hydrogen which they contain; and are decomposed by chlorine, iodine, bromine, and the acids. Some of them (as the Oil of Turpentine) combine with hydrochloric acid. They are very slightly soluble only in water. The *distilled waters* of the Pharmacopœia are saturated solutions of them. If the oils be previously rubbed with sugar they dissolve more readily in water. The mixtures or compounds of volatile oils and sugar are called *elæosacchara.* According to the Prussian Pharmacopœia they are composed of one drop of oil and a scruple of sugar. Volatile oils dissolve readily in alcohol, ether, pyroxilic spirit, and naphtha, and easily mix with the fixed oils and resins.

The volatile oils, as ordinarily met with, usually consist of two oils—the one liquid, at ordinary temperatures (*volatile oil*, properly so called; the *éleoptène* of Berzelius; the *hygrusin* of Bizio)—the other solid (*stéaroptène* of Berzelius; *stereusin* of Bizio; *camphor* of the German chemists). When the latter predominates, the oil readily concretes in cold weather—as the Oil of Anise and the Oil of Star-anise. The Camphor of the shops is a solid volatile oil (*stéaroptène*).

In regard to ultimate composition the volatile oils may be divided into three classes: 1st, some of them are *hydro-carbons;* that is, are composed of carbon and hydrogen only—as the Oils of Turpentine, Juniper, Savin, Lemon, and Bergamot: 2dly, some are *oxy-hydro-carbons;* that is, they consist of oxygen, hydrogen, and carbon: as the Oils of Lavender, Anise, Mint, and Rosemary: 3dly, some are *Azoturetted* or *Sulphuretted*, and contain no less than five indgredients; namely, carbon, hydrogen, oxygen, sulphur, and nitrogen; as the Volatile Oil of Mustard. It is remarkable that all the volatile oils which contain carbon and hydrogen only, have the same ultimate composition (10 C + 8 H); or, at least, they consist of the same elements in the same relative proportion.

The volatile oils undergo chemical changes when exposed to the air. They become deeper coloured and thicker, absorb oxygen, and give rise to the formation of carbonic acid and resin. The resins of Turpentine and Copaiva appear to be simple oxides of their respective oils.

2. **Resin** (*resina*).—This is rarely found in the mineral kingdom, or in animal substances; but is common in vegetables. In the latter it exists almost invariably, if not universally, in combination with volatile oil, from which, perhaps, it may be formed by the action of the oxygen of the air. It is a transparent or partially opaque, hard, soft, or elastic solid; coloured or colourless; lighter or heavier than water, its sp. gr. varying from 0·93 to 1·2[y]; fusible and combustible.

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[x] L. Gmelin, *Handbuch der theoretischen Chemie*, 2er Bd. S. 351. 1829.

[y] Gmelin, *op. supra cit.*

It is a bad conductor of electricity, and becomes negatively electrical by friction. As commonly met with it is odorous, but probably, if completely deprived of volatile oil, would be inodorous. Its taste is usually more or less acrid; sometimes bitter, and, occasionally, is not perceptible. It is not soluble in water, though some resins form hydrates with this liquid. It is soluble in ether and volatile oil, and frequently more or less so in alcohol; and on the addition of water to the alcoholic solution, the resin is thrown down as a white powder, which gives a milky appearance to the fluid.

Most resins possess acid properties; that is, they redden litmus, and combine with alkalis and other metallic oxides. This is the case with the two resins (*Pinic* and *Sylvic acids*) of which Colophony is composed; as well as the resin of Copaiva (*Copaivic acid*); of Guaiacum (*Guaiacic acid*); of Gamboge (*Gambogic acid*), &c. The salts formed by the union of resins with alkalis, or other basic substances, are called *resinous soaps.* The *sapo-guajacinus* and *sapo jalapinus* of the Prussian Pharmacopœia, as well as the *savon de térébinthine* (*Starkey's soap*) of the French Codex, are soaps of this kind, and will be noticed hereafter.

The resins are composed of *carbon*, *hydrogen*, and *oxygen*[1]. Some of them (*e. g.* Turpentine and Copaiva resins), appear to be oxidized essential oils. It is not improbable that the first degree of oxygenation of the volatile oils forms resins insoluble in cold alcohol, while the most oxygenated are soluble in this liquid.

Class 3. Medicamenta Tonica.—Tonics.

(Corroborants.)

Definition.—Under the denomination of tonics are usually comprehended those therapeutic agents which, by continued administration in debilitated and relaxed conditions of the body, increase gradually and permanently the tonicity of the whole system, and thereby render the fibres tenser and stronger, and give greater firmness and density to all the tissues and organs. They have received their names from τόνος, *tone* or *vigour*, on account of their strengthening or invigorating properties.

Physiological Effects.—Tonics produce their proper or real tonic effects in certain conditions of the system only; that is, they do not invariably strengthen. In some cases they give rise to no obvious results—in others they act as irritants and stimulants. In the healthy state moderate doses produce no sensible effects, or, perhaps, a slight excitement of the appetite merely, while large quantities give rise to nausea and vomiting. In irritation or inflammation of the stomach and intestines, and in febrile conditions of system, attended with a hot and dry skin, and a furred and dry tongue, tonics act as local irritants and excitants, and add to the severity of all the morbid symptoms. In a weak and debilitated condition of body, they act very differently. Their immediate effects are to increase the appetite and assist digestion. After they have been administered for some time, the soft solids (as the muscles, cellular tissue, &c.) become firmer, the muscular system more powerful, and the pulse stronger, though not quicker. In fact, all the functions are performed with more energy, and the patient is capable of greater exertion.

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[1] Professor Johnston has published a series of elaborate papers *On the Constitution of the Resins*, in the *Philosophical Transactions* for 1839 and 1840.

Tonics sometimes purge, at others constipate. When diarrhœa arises from, or is kept up by, a weakened state of the intestinal tube, tonics, by restoring strength, may produce constipation. On the other hand, when constipation depends on a debilitated and torpid condition of this tube—a circumstance not uncommon in females, tonics not unfrequently occasion alvine evacuations. Dr. Cullen having noticed how frequently bitters act as laxatives and purgatives, has inserted them in his list of cathartics.

Tonics are closely connected with stimulants; and on many occasions, the so-called tonic substances act really as stimulants. Thus in weak but irritable subjects just recovering from a protracted state of fever, Sulphate of Quinia will frequently act both as a local irritant and stimulant, and produce nausea, vomiting, furred tongue, a febrile state of system, headache, &c. In fact, the two classes (tonics and stimulants) mutually approach and gradually pass the one into the other, and several substances may with equal propriety be arranged under either.

Tonics are also closely related to the cerebro-spinants. Several of the vegetable bitter tonics especially affect the cerebro-spinal system (for example, Quassia); while some of the cerebro-spinants (as Strychnia), in very small doses, act as tonics. Moreover, the beneficial influence of some of the vegetable tonics (as Cinchona) in intermittent diseases, should probably be referred to the specific effects of these agents on the nervous system. And, in the same way, we ought to explain the power of tonics to increase the tone of the muscular system; for it appears from Dr. Marshall Hall's experiments[a], that one function of the true spinal system is to give tone to the muscles.

The Preparations of Arsenic, Silver, Copper, Bismuth, Zinc, &c. are usually, but, as I think, most improperly, denominated tonics. They are agents which, in small and repeated doses, as well as in large and poisonous doses, specifically affect the nervous system, and I have already referred to them under the class of cerebro-spinants. They have been called tonics principally for the following reason:—Cinchona, the most powerful of the vegetable tonics, and, in fact, the type of the class, has long been celebrated as a curative agent in ague and other periodical diseases; hence it has been assumed that any substances capable of fulfilling the same indication must be possessed of the same properties, and thus Arsenic has been called a tonic. But the conclusion is erroneous; it is indeed true that Cinchona and Arsenic have, in common, the power of curing an ague, but the same effect is frequently produced by many other very dissimilar substances: for example, by Bloodletting, by Alcohol, and by Mental Influences. If, therefore, Arsenic be a tonic, so also must bloodletting, &c. If we admit this, it follows tonics can no longer be regarded as substances promoting strength, but merely as agents curing particular diseases. Before we have any right to associate Arsenic among tonics, we must completely alter our definition of these substances, or show that Arsenic improves the appetite and promotes the strength of the body.

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[a] *On the Diseases and Derangements of the Nervous System*, p. 78. Lond. 1841.

Tonics may be arranged in orders or groups, as follows:—

ORDER 1. SIMPLE BITTERS.—This order includes those vegetable tonics which possess bitterness with little or no astringency; and which have been termed *bitters* (*amara*), or sometimes *pure* or *simple bitters* (*amara pura* seu *simplicia*). To this group are referred Quassia and Simaruba, obtained from the order *Simarubaceæ;* Gentian, American Calumba (*Frasera*), Chirayta, Common Centaury, and Buckbean, from *Gentianaceæ;* Calumba and *Pareira brava* from *Menispermaceæ;* and *Cetraria islandica*, from *Lichenaceæ.* The latter is a *mucilaginous* or *demulcent tonic.* These remedies are employed to promote the appetite and assist digestion in atonic and enfeebled conditions of the stomach; as general tonics in feebleness and debility of the whole system, and especially of the muscles; as antiperiodics in intermittent diseases; and as anthelmintics. Their beneficial operation in expelling intestinal worms has been referred to their poisonous influence over these parasitical animals, but ought perhaps rather to be ascribed to their improvement of the condition of the alimentary canal, and to the removal of those states which favour the production of these beings. The power which they possess of retarding the acetous fermentation may, perhaps, contribute to their beneficial operation in some dyspeptic cases accompanied with acidity and flatulence.

ORDER 2. PURE VEGETABLE ASTRINGENTS[b].—This order comprehends those vegetable tonics which possess considerable astringency with little or no bitterness. These are the *pure astringents* (*astringentia pura*). In this group are contained Oak-bark and Nut-galls, from the order *Cupuliferæ;* Uva-ursi, from *Ericaceæ;* Catechu and Logwood, from *Leguminosæ;* Rhatany, from *Polygalaceæ;* Tormentilla, from *Rosaceæ;* the Pomegrante-rind, from *Myrtaceæ;* Bistort, from *Polygonaceæ;* and to these may be added Kino. These agents are principally remakable for causing local contraction and corrugation (or astriction) of the tissues. They contract and give greater density to the muscular fibres; diminish the calibre of the blood-vessels and exhalants, and thereby check hemorrhage (whence their denomination of *styptics*), and diminish secretion and exhalation when applied to mucous membranes or other secreting surfaces. In the mouth they give rise to a peculiar sensation of roughness and stypticity. Some writers have ascribed these effects to a chemical or physical agency. Thus Dr. Cullen places astringents among substances acting on the simple solids, though, in another part of his treatise, he admits that they act on the living, as well as on the simple solids. The late Dr. Adair Crawford[c] ascribed the effects of both astringents and bitters to their influence in promoting the cohesion of the animal fibre. He immersed some pieces of intestines, of skin, &c., in various bitter and astringent infusions, while others were placed in water, merely as a standard; and he then observed the comparative weights required to break them, from which he inferred the relative strength of different tonics. But this mode of reasoning naturally leads to erroneous inferences, since the vital powers of the system are quite overlooked. The relaxed state of parts, which astringents are useful in obviating, depends not on a mere mechanical or chemical alteration, but in some change in the state of vital powers; and, therefore, the agents which counteract it, must have some other than a mere physical action. Moreover, the results obtained by Dr. Crawford depended probably on the different degrees of antiseptic power possessed by the substances employed. Astringents produce the constitutional effects of the bitter tonics: administered in moderate doses, they promote the appetite, assist digestion, and increase the tone and vigour of the general system. They are capable of fulfilling the same therapeutic indications as the bitter tonics. Thus, they have the power of preventing the occurrence of a paroxysm of intermittent fever; and in cases of debility are often useful, independently of their power of checking debilitating discharges. But this group is principally employed for its local effects; to obviate relaxation of fibres and tissues, and to prevent or check excessive discharges.

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[b] For some observations on the distinction between astringency and bitterness, see Perceval's *Essays*, vol. i. 2d edition. London, 1772.

[c] *An Experimental Inquiry into the Effects of Tonics, &c.*, 1816.

ORDER 3. ASTRINGENT BITTERS.—This order contains those vegetable tonics which possess both bitterness and astringency in an eminent degree; it may, therefore, be denominated *astringent bitters.* It includes Cinchona-bark, from *Cinchonaceæ;* Spigelia, from *Spigeliaceæ;* Elm-bark, from *Ulmaceæ;* and Willow-bark, from *Salicaceæ.* It combines the effects of both bitters and astringents, and is by far the most important group of the class, since it contains Cinchona-bark, the most powerful of the vegetable tonics.

ORDER 4. AROMATIC BITTERS.—This order contains the *aromatic bitters,* which possess bitterness, with an aromatic flavour (derived from the presence of volatile oil), and, in some cases, astringency likewise. This group contains Wormwood and Elecampane, from the order *Compositæ;* Cascarilla, from *Euphorbiaceæ;* Angustura-bark, from *Rutaceæ;* and Hops, from *Urticaceæ.* They possess the combined properties of aromatics and bitter tonics, and are, therefore, useful where these are indicated.

ORDER 5. ACID TONICS.—This order contains the *acid tonics;* namely, the Mineral Acids, to which, perhaps, may be added Alum. These, taken in the dilute state, allay thirst, promote the appetite and digestive process, and augment the secretion of urine. By continued use, they reduce the heat of the body; diminish the fulness and quickness, but increase the firmness, of the pulse; check the cutaneous and pulmonary exhalation and secretion; and heighten the general tonicity of all the fibres and organic tissues. If their employment be continued for too long a period, the digestive functions become much disturbed, chronic inflammation of the mucous lining of the alimentary canal is set up, accompanied with wasting and disorder of the whole system. They are employed as cooling and temperant means in fevers, especially of the hectic kind, and likewise as tonics. They are useful adjuncts to some of the bitter infusions.

ORDER 6. METALLIC TONICS.—This order consists principally of the Preparations of Iron. These combine tonic and stimulant properties, and will be noticed hereafter.

ACTIVE PRINCIPLES.—The active principles of the vegetable tonics are *vegetable alkalis, non-alkaline crystalline substances* analogous to the alkaloids, certain *vegetable acids,* and the substance called *extractive.*

1. VEGETABLE ALKALIS.—Quina, Cinchonia, and Aricina, are tonic vegetable alkalis. The general properties of this class of substances have been already examined[d].

2. NON-ALKALINE NEUTRAL CRYSTALLINE PRINCIPLES.—Salicine, Quassine, &c. have some analogy to the vegetable alkalis, but are too imperfectly known to permit any general account of them to be given.

3. CERTAIN TONIC VEGETABLE ACIDS.—*Tannic, Gallic,* and *Catechuic Acids,* appear to possess tonic properties.

a. Tannic acid (*acidum tannicum*).—As this substance is employed in medicine, it will be described in a subsequent part of this work. It will be sufficient, therefore, here to state, that its presence in the astringent tonics is shown by the whitish, or yellowish-white, precipitate (*tanno-gelatin*), which infusions of these substances form with a solution of isinglass, and by the blue precipitate (*pertannate of iron*) which they give on the addition of a perferruginous salt. It also causes precipitates (*tannates*) with the vegetable alkalis.

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[d] See p. 179.

β. *Gallic acid* (*acidum gallicum*).—The properties of this acid are very similar to those of tannic acid. From this circumstance, as well as from the fact that gallic acid is easily produced by the action of air on tannic acid, it is difficult to prove whether certain vegetable substances contain both these acids, or only tannic acid. Gallic acid agrees with tannic acid in producing a deep blue colour with the persalts of iron, but it does not precipitate gelatine or the vegetable alkalis. Though obtained from several vegetables, yet it probably either does not exist in many of them, or is present in very small quantities only: it is to be regarded, in most cases, as a product rather than an educt. Thus, though nutgalls yield one-fifth of their weight of gallic acid, Pelouze thinks that, originally, they contain none of it, but that what is procured is obtained by the action of atmospheric air on the tannic acid. Taken internally, in small doses, gallic acid causes no inconvenience. It has been given in the dose of from fifteen to thirty grains, against the *Tænia Solium*, but without any benefit. Swallowed to the extent of twenty-four grains, it gave rise to a sweetish taste and a slight feeling of internal heat, but no other symptom[e].

γ. *Catechuic Acid.*—This is a constituent of several vegetable astringents; as Catechu, Gambier, &c. It probably constitutes the essential part of the substance called by Pelletier *red cinchonic.* It produces a green colour with the salts of iron, but does not occasion any precipitate in a solution of gelatine. Its physiological effects have not been ascertained.

4. EXTRACTIVE.—Some of the vegetable tonics are said to owe their bitterness and medicinal activity to a principle to which the terms *materia hermaphrodita*, *materia saponacea*, and *extractive matter*, have been applied. It is described as being of a brown colour, soluble in water and alcohol, insoluble in ether, and becoming insoluble in water, by long-continued boiling, and by exposure to light and air. That a substance, or mixture of substances, possessed of these properties, may be obtained from various plants, cannot be doubted, but it is not probable that chemists have yet succeeded in obtaining a proximate principle to which the term extractive can with propriety apply. What has hitherto been procured is a mixture or compound of several principles, such as vegetable acids and their combinations with potash and lime, colouring matter, sugar, gum (rendered soluble in alcohol by its combination with other substances), vegetable bases, &c.

CLASS 4.—MEDICAMENTA EMOLLENTIA—EMOLLIENTS.

(Demulcents.)

DEFINITION.—Agents which diminish tone or insensible contractility of the living tissues to which they are applied, and thereby cause relaxation and weakness, are denominated *emollients* (from *emollio*, I soften).

PHYSIOLOGICAL EFFECTS.—They have an operation diametrically opposite to tonics, especially to those which are astringent. They relax, soften, and swell the tissues, and render them more flexible. Applied to inflamed parts they diminish heat, tension, and pain, and oftentimes assist in producing the resolution of the disease; and when the inflammation is too violent, or too far advanced, for this to be effected, they are useful by promoting suppuration. They have a relaxing effect on the muscular fibre, and are, therefore, employed to relieve spasm. These effects have been referred, by some, to a physical, by others, to a vital agency. During life the particles of the body are kept in approximation by two forces—attraction and the vital principle; and as emollients render the parts to which they are applied soft and flexible, that is, they produce relaxation, it becomes a question whether they operate by overcoming the cohesion of the molecules, or by modifying the vital properties. Most writers have regarded them as mechanical agents, and explain their influence just as they account for the action of warm water, or oil, on inorganic substances—leather, for example. But we should always be cautious in applying physical explanations to vital phenomena; and in the present instance this is particularly necessary. Emollients act physically on inorganised parts of the body (the cuticle, for example), but on living parts they exert another kind of influence; for cold water, which diminishes the cohesion of dead parts and renders them softer and more flexible, has not the same effect on living tissues. Moreover, Dr. A. Crawford[f] has shewn that some medicinal agents diminish the cohesion of dead animal tissues, and have an opposite effect on the living ones.

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[e] Chevallier, in the *Dictionnaire des Drogues simples et composées,* t. i. p. 93. Paris, 1827.

The constitutional effects of emollients are for the most part those of nutrients, not of medicines; though the continued use of some is said to diminish the tone or vigour of the system generally—an effect ascribed by Barbier[g] to their absorption and local action on all the fibres of the body. This statement, however, is unsupported by fact in the case of gum, starch, sugar, gelatine, albumen, and some other principles.

Emollients are used to prevent the action of irritating matters on the body, by involving them, or by sheathing or defending surfaces from the action of substances capable of acting on them injuriously. When used for these purposes they are denominated *demulcents* (*demulcentia*, from *demulceo*, to mitigate or soften). Thus we administer them when acrid poisons have been swallowed. They are applied externally, in the form of local baths, poultices, fomentations, &c. both as emollients and demulcents, in local inflammations, painful ulcers, &c. In irritation, inflammation, and ulceration of the alimentary canal (as in gastritis, enteritis, diarrhœa, dysentery, &c.), they are taken either by the mouth or in the form of clyster. In catarrh, peripneumony, and pulmonic affections in general, where the cough is dry and harsh, and the expectorated matters are acrid, the use of emollients is often attended with very beneficial effects. By their lubricating and soothing influence over the nerves distributed to the fauces, they probably affect the bronchial membrane and pulmonic structure by a reflex action. In affections of the urinary passages, as ardor urinæ, emollients (especially aqueous fluids) are very serviceable.

Emollients may be arranged in the following orders:—

ORDER 1. AQUEOUS EMOLLIENTS.—This order contains Water, the principal and most important substance of the class. In order, however, that it may act as an emollient, it must have a certain temperature; for neither very cold nor boiling water has any emollient effect. Dr. Cullen fixes 62° F. as the lowest temperature at which this fluid can be emollient; and observes, that the greater its warmth the greater will be its emollient power, provided that pain or scalding be not produced. Aqueous vapour is, for two reasons, more emollient than liquid water: in the first place, it penetrates the organic tissues more powerfully; and, secondly, a greater degree of heat can be applied by it than by liquid water. Dr. Cullen was doubtful whether advantage could be gained by any addition made to water.

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[f] *Op. cit.*

[g] *Traité Elémentaire de Matière Médicale*, t^{e} ii. 2nde éd. Paris, 1824.

ORDER 2. MUCILAGINOUS EMOLLIENTS.—This group has been subdivided into the pure mucilaginous emollients (as Gum Arabic, Tragacanth, Mallow, Marshmallow, &c.), the sweets (as Figs), the bitters (as *Cetraria islandica,* Coltsfoot, and Sarsaparilla), and the oily (as Linseed, Sweet Almonds, Poppy seeds, &c.)

ORDER 3. AMYLACEOUS EMOLLIENTS.—This order includes starchy or farinaceous substances; as Wheaten Flour, Oatmeal, Barley, Arrow-root, Sago, Tapioca, ordinary Starch, &c.

ORDER 4. SACCHARINE EMOLLIENTS.—This order consists of the saccharine substances; as ordinary Sugar, Honey, Liquorice, &c.

ORDER 5. OLEAGINOUS EMOLLIENTS.—This order includes the waxy, fatty, and oily substances; such as the animal fats, &c. (as Lard, Mutton Suet, Butter, Wax, and Spermaceti), and the vegetable oils (as Olive, Almond, Sesami, Palm, Poppy, Linseed, &c.)

ORDER 6. ALBUMINOUS EMOLLIENTS.—This includes the White and Yolk of Eggs, and Milk. Saliva and gastric juice are employed on the continent for medical purposes.

ORDER 7. GELATINOUS EMOLLIENTS.—This order comprehends the gelatinous substances; as Gelatine in its pure form, Isinglass, Hartshorn shavings, &c.

ACTIVE PRINCIPLES.—*Water* and *oily substances* are, perhaps, the essential emollient principles. For though *gum*, *starch*, *sugar*, *albumen*, and *gelatine*, are termed emollient principles, they do not act as such unless water be present. The properties of these principles will be described in other parts of this work.

CLASS 5. MEDICAMENTA REFRIGERANTIA.—REFRIGERANTS.

(Temperants.)

DEFINITION.—Medicinal substances which diminish the temperature of the body when it is preternaturally increased, are denominated *refrigerants* (from *refrigero,* I cool), or *temperants* (from *tempero,* I moderate).

PHYSIOLOGICAL EFFECTS. — The only agent which in all cases reduces animal heat, is cold, used in the form of ice, cold air, cold baths, cold lotions, cold drinks, &c. Their agency is obvious: they abstract heat, and thereby lower the intensity of the vital movements, diminish vascular action, and reduce the calorific functions[h]. But there are certain medicinal substances which, by continued internal use, allay febrile heat, and usually promote the secretions, though they have no power of diminishing the ordinary or healthy temperature, and to these the term refrigerant is usually applied. How they act is not completely understood. Dr. John Murray[i] thought they furnished oxygen to the system, and in that way prevented so large a quantity of it being consumed in the process of respiration,—an explanation borne out by the observations of Mr. Spalding and Dr. Fyfe[j], that vegetable diet reduces the consumption of oxygen gas in respiration.

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[h] See p. 21.

[i] *A System of Materia Medica and Pharmacy,* 5th ed. vol. i. p. 508. Edinb. 1828.

Refrigerants may be arranged in two orders, as follows:—

ORDER 1. ACIDULOUS REFRIGERANTS.—This order consists of the mineral and vegetable (Sulphuric, Hydrochloric, Acetic, Citric, Tartaric, &c.) acids, as well as the acid- or super- salts (Alum and Bitartrate of Potash). To the same order also belong certain acidulous fruits (as Oranges, Lemons, Mulberries, Tamarinds, Prunes, fruit of the Dog-rose, &c.), and herbs (as Wood Sorrel, Common Sorrel, Lettuce, &c.), and Acid Whey *(serum lactis acidum)*.

ORDER 2. SALINE REFRIGERANTS.—This order includes certain neutral salts; namely, the Nitrate and Chlorate of Potash.

ACTIVE PRINCIPLES.—*Acids* and the *Alkaline Salts* are the active principles of this class.

CLASS 6. MEDICAMENTA EVACUANTIA.—EVACUANTS.

(Vito-secerning Agents, *Nuttall;* Vital Agents which operate on the secerning system, *A. T. Thomson.*)

DEFINITION.—Agents which provoke a discharge by some emunctory, are termed *evacuants* (from *evacuo*, I evacuate or make void).

PHYSIOLOGICAL EFFECTS.—As evacuants promote secretion, their action on the secreting organs must be that of excitants; and, when carried too far, is followed by inflammation. They are employed to restore natural secretion, the diminution or stoppage of which has arisen from torpor, or deficient vascular activity of the secreting organ. But their secondary effect is exhaustion; and thus these agents, having a weakening or depressing influence on the system, are employed as antiphlogistics, and are denominated contra-stimulants or hyposthenics by the supporters of the doctrine of contra-stimulus[k]. They diminish the quantity of circulating fluid; and hence they are obviously indicated in plethora. By their depressing influence over the vascular system, as well by their power of unloading the blood-vessels, they indirectly promote absorption; and are, in consequence, used in dropsical cases to hasten the removal of the effused fluid. I have already alluded (pp. 9 and 147) to the mutual influence which the secretions have over each other[l], and which constitutes what has been denominated the *antagonism* of the secretions. In therapeutics we sometimes take advantage of this and excite the secretion of one organ, with the view of diminishing that of another. Moreover, we frequently employ evacuants as revulsives (see p. 146), to relieve local determinations of blood to parts remote from those on which the evacuant operates. Thus purgatives are employed in affections of the head. Some of the milder evacuants, which gently and moderately promote the action of two or more secreting organs, are beneficially employed in chronic diseases under the name of *alteratives*, or *purifiers of the blood.* The agents called *resolvents* (as Mercury, Iodine, and the Alkalis), and which are used to combat visceral and glandular enlargements, augment the activity of the secreting organs.

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[j] *Annals of Philosophy*, vol. iv. p. 334. Lond. 1814.

[k] See p. 129.

[l] "Since all secretions, inasmuch as they extract certain ingredients from the blood, produce a change in its composition, no one secretion can be altered in quantity or quality without disturbing the balance which exists between all in their action on the blood; hence, the increase of one secretion gives rise to the diminution of another" (Müller's *Physiology*, by Baly, vol. i. p. 473).

MODUS OPERANDI.—In a considerable number of cases evacuants exert a topical, stimulant, or irritant influence over the organs whose secretions they augment. In some instances we apply them directly to the part on which we wish them to act; as in the case of Errhines, Masticatories, and Cathartics (usually). In other instances, the active principle of the evacuant is absorbed, circulates with the blood, and is thrown out of the system by the secreting organ, whose activity it augments. It is probable, therefore, in this case, that the increased secretion arises from the local stimulus communicated to the secreting vessels by the evacuant (or its active principle) in its passage through them. The operation of the Turpentines and Copaiva on the mucous surfaces, and of many diuretics on the kidneys, is readily accounted for in this way.

ACTIVE PRINCIPLES.—*An acrid principle* is found in a considerable number of the medicines of this class. The *salts of the alkalis* operate as evacuants.

ACRID PRINCIPLES.—*Acrids* are organic substances which irritate or inflame living parts with which they are placed in contact, independently of any known chemical action. They were formerly supposed[m] to owe their activity to a peculiar proximate principle, which was denominated the *acrid principle of plants (principium acre plantarum)*; but modern chemistry has shewn that there is no one constituent of organic substances to which this term can be exclusively applied; but that many dissimilar principles agree in possessing acridity. Thus acrid substances are found among *acids* (e. g. Crotonic, Ricinic, and Gambogic), *vegetable alkalis* (e. g. Veratria and Emetia), *neutral crystalline matters* (e. g. Elaterin), *volatile oils* (e. g. Cantharadin, and the Oils of Mustard, Garlic, and Rue), *resins* (e. g. the resins of Euphorbium and Mezereon), and *extractive matter* (e. g. Colocynthin). The acrid matter of some plants (e. g. of Ranunculus) has not yet been isolated. This arises from the facility with which it becomes decomposed.

SUB-CLASS 1. *LIQUEFACIENTIA.—LIQUEFACIENTS.*

(Verflüssigende Mittel, *Sundelin.*)

DEFINITION.—Medicinal agents which augment the secretions, check the solidifying, but promote the liquifying, processes of the animal economy, and which, by continued use, create great disorder in the functions of assimilation, may be termed *liquefacients* (from *liquefacio*, I liquify).

Practitioners must have long felt the want of some term which should indicate the physiological action of Mercury, Antimony, Iodine, the Alkalis, and other medicinal agents employed as resolvents. To supply this desideratum I have adopted, in the absence of a better, the word Liquefacient.

PHYSIOLOGICAL EFFECTS.—Liquefacients promote secretion and exhalation generally. Thus Mercurials augment the secerning functions of the mucous follicles of the mouth, the salivary glands, the alimentary canal, the liver, the kidneys, and the skin ; and it is probable that they also increase the secretions of the pancreas and the exhalation from the pulmonic surface. Antimonials, Iodine, and the Alkalis, exert a similar, though not equally powerful, influence over the same organs. So that in their effects on these parts, liquefacients correspond with the ancient *panchymagogues* (from πᾶν, all; χυμὸς, juice; and ἄγω, I drive away), or medicines which were supposed to purge away all sorts of humours.

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[m] See the *Principles of Modern Chemistry systematically arranged*, by Dr. F. C. Gren., translated from the German, vol. i. p. 428. Lond. 1800.—Also Gura, *De Principio Plantarum acri.* Halæ, 1791.

They also check solidifying, while they promote liquefying, processes in the animal economy; and on this account I have ventured to name them *liquefacients*, a term which corresponds nearly with the phrase *verflüssigende Mittel*, used by Sundelin[n]. Thus these agents soften and loosen textures, and assist the removal of adhesions and exudations. This effect is best seen after the use of mercurials, the action of which, observes Dr. Farre[o], "is positively anti-phlegmonous. If it be pushed far enough, it produces an effect the exact reverse of the phlegmonous state, namely, the erythematous inflammation; the tendency of which is to loosen structure, while that of phlegmonous inflammation is to bind texture." Under the influence of Mercury the gums become spongy, the intestinal and pulmonic membranes softened[p], and deposits of coagulable lymph (as in Iritis) are removed. The beneficial effects of Mercurials, Antimonials, Iodine, Alkalis[q], &c. in promoting the resolution of visceral and glandular inflammation, and in relieving active congestion, may be ascribed to this anti-phlegmonous action referred to by Dr. Farre. These agents are opposed to the exudation of plastic or coagulable lymph (hence they check union by adhesion), and to the formation of false membranes. During their use, visceral and glandular enlargements and indurations, thickening of membranes (as of the periosteum), and morbid, but non-malignant, growths of various kinds, are sometimes observed to get softer and smaller, and ultimately to disappear. Dr Ashwell[r] graphically describes indurations, and hard tumours of the uterus, as having "melted away" under the influence of Iodine. In hepatization of the lungs, the solid matter, deposited in the air-cells, is often absorbed, and the cells rendered again permeable to air, by the use of Mercury. It is on account of the influence of liquefacients in checking phlegmonous inflammation, obviating its consequences, and promoting the removal of enlargements, indurations, &c. that they are frequently denominated *resolvents* (from *resolvo*, I loosen or dissolve). Lastly, the long-continued use of liquefacients gives rise to a considerable disorder of the functions of assimilation.

A course of Mercury, it is well known, produces paleness or blanching; an effect which Dr. Farre[s] ascribes to the diminished number of red globules of the blood. A prolonged use of this mineral gives rise to other symptoms of cachexy. The long-continued employment of Alkalis appears to induce a scorbutic cachexy[t]. Iodine causes a morbid state, which has been termed *iodism.*

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[n] *Handbuch der speciellen Heilmittellehre*, Bd. i. S. 180, 3te Aufl. Berlin, 1833.

[o] *Essays on the most important Diseases of Women*, by Robert Ferguson, M.D. Part i. p. 215. Lond. 1839.

[p] Ferguson's *Essays*, p. 216.

[q] Mascagni, in the *Memorie della Società Italiana delle Scienze*. Modena, 1804.—Also Negri, in *Lond. Medical Gazette*, vol. xiv. p. 713.

[r] *Guy's Hospital Reports*, No. I. 1836.

Our acquaintance with the extent of the order of liquefacients is too limited to enable us to group them for any useful purpose. As a provisional arrangement of them I suggest the following :—

ORDER 1. MERCURIAL LIQUEFACIENTS.
ORDER 2. ANTIMONIAL LIQUEFACIENTS.
ORDER 3. IODIC LIQUEFACIENTS.
ORDER 4. ALKALINE LIQUEFACIENTS.
ORDER 5. SALINE LIQUEFACIENTS, including probably Sal Ammoniac, Common Salt, Chloride of Barium, &c.
ORDER 6. SULPHUROUS LIQUEFACIENTS, comprehending Sulphur, and the Alkaline Sulphurets.

MODUS OPERANDI.—The resolvent operation of medicines of this order is usually explained by referring it to an augmented activity of the absorbents. But this explanation is imperfect, and does not account for all the phenomena. The effect is ascribable to a change in the nutrition of the parts affected. My friend, Dr. Billing[u], is of opinion that "Mercury and Iodine remove morbid growths by starving them, which they effect by contracting the capillaries." But I conceive there must be something more in the influence of these remedies than a mere reduction in the quantity of blood supplied to the affected parts. The enlargements which these agents remove are not mere hypertrophies ; their structure is morbid, and they must, in consequence, have been induced by a change in the quality of the vital activity ; in other words, by morbid action. Medicines, therefore, which remove these abnormal conditions, can only do so by restoring healthy action,—that is, by an alterative influence. By what force or power they are enabled to effect changes of this kind must, for the present at least, be a matter of speculation. Müller[v] thinks it is by affinity. " They produce," he observes, " such an alteration in the composition of the tissues, that the affinities already existing are annulled, and new ones induced, so as to enable the vital principle—the power which determines the constant reproduction of all parts in conformity with the original type of the individual—to effect the further restoration and cure ; the Mercury itself does not complete the cure."

SUB-CLASS 2. *DIAPHORETICA.—DIAPHORETICS.*

(Sudorifica ; Diapnoïca.)

DEFINITION.—Medicinal agents, which promote cutaneous transpiration, are denominated *diaphoretics* (from διαφορέω, I transpire),

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[s] Ferguson's *Essays*, p. 216.
[t] See Huxham's *Essay on Fevers*, pp. 48 & 308. 3d edit. 1757.—See also Dr. Burrows's *Gulstonian Lectures* in the *London Medical Gazette*, vol. xiv.
[u] *First Principles of Medicine*, pp. 69, 70. 4th ed. Lond. 1841.
[v] *Physiology*, by Baly, vol. i. p. 363.

sudorifics (from *sudor*, sweat, and *facio*, I make), or *diapnoïcs* (from διαπνοή, perspiration).

The terms *diaphoretic* and *diapnoïc* have been used to designate substances which augment the insensible perspiration; while the word *sudorific* indicates a substance increasing the sweat or sensible perspiration. But insensible perspiration and sweat differ in their physical conditions only,—the former being the vaporous, the latter the liquid state of the same fluid. Hence there can be no essential difference between diaphoretics and sudorifics, and I, therefore, use the terms synonymously.

PHYSIOLOGICAL EFFECTS.—The agents which, under certain circumstances, augment cutaneous exhalation, are both numerous and heterogeneous. External heat, assisted by the copious use of diluents, constitutes an important and powerful means of promoting sweating. Whenever a large quantity of fluid is taken into the system, the excess is got rid of by the kidneys, the skin, and the lungs; and if we keep the skin warm, as by warm cloathing, or the use of hot air or hot vapour-bath[w], the action of the cutaneous exhalants is promoted, and sweating results; but if the skin be kept cool, the kidneys are stimulated, and the greater part of the liquid passes off through them. Friction, exercise, and all agents which excite vascular action, have a tendency to promote sweating. The sudden and temporary application of cold, as in the affusion of cold water[x], sometimes proves sudorific by the reaction which it occasions. Lastly, many medicinal agents, acting through the circulation, cause sweating. The latter are the substances which are usually indicated by the word sudorific or diaphoretic.

Diaphoretics are relative agents; they succeed only in certain states of the body. Moreover, for different conditions, different diaphoretics are required. They constitute an exceedingly uncertain class of remedies, with regard both to the production of sweating and to the advantage to be derived therefrom. Dr. Holland[y] suggests that when benefit follows the use of diaphoretic medicines, it is often ascribable, not to their direct influence on the exhalant vessels, but to other changes which they excite in the system, of which sweating is to be regarded rather as the effect and proof than as the active cause.

The operation of diaphoretics is promoted by the exhibition of large quantities of warm mild diluents, and by keeping the skin warm. Moreover, they are more effective when given at bed-time, since there appears to be greater disposition to sweating during sleep than in the waking state. The exhibition of diuretics should be avoided during the operation of diaphoretics, as they appear to check the operation of the latter. The same rule has been laid down with regard to purgatives; but it is well known that perspiration is often the consequence of hypercatharsis.

Diaphoretics may be arranged in seven orders, as follows:—

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[w] See pp. 12, 15, and 19.

[x] See p. 27.

[y] *Medical Notes and Reflections*, p. 52. Lond. 1839.

ORDER 1. AQUEOUS DIAPHORETICS. — Under this head are included not only simple Water, but Gruel, Whey, and Tea. These, when assisted by external warmth, often prove very effective diaphoretics, even when used alone, while to all the other groups they are valuable adjuvants; and in no cases are they injurious.

ORDER 2. ALKALINE AND SALINE DIAPHORETICS. — The salts of the alkalis are frequently used to promote perspiration. Acetate and Carbonate of Ammonia, Alkaline Citrates and Tartrates, Sal Ammoniac, and Nitrate of Potash, are employed for this purpose in fevers.

ORDER 3. ANTIMONIAL DIAPHORETICS.—The liquefacient operation of Antimonials has been already referred to. Diaphoresis is one of its consequences. We use this group of diaphoretics in febrile and inflammatory cases. It is preferred to the opiate diaphoretics when there is inflammation or congestion of the brain, or a tendency to either of these conditions.

ORDER 4. OPIATE DIAPHORETICS. — Opium and its alkali Morphia have a remarkable tendency to produce sweating. The former is often used as a diaphoretic, commonly in the form of Dover's Powder, when no disorder of the brain exists; and especially when an anodyne is indicated. When the stomach is very irritable, an opiate diaphoretic is preferred to an antimonial one. In rheumatism, and slight catarrhs, Dover's Powder proves highly serviceable. In diabetes and granular disease of the kidneys, it is the best sudorific we can use, especially when conjoined with the warm bath[z]. Opium and Camphor form a serviceable sudorific compound when the surface is cold, as in Cholera.

ORDER 5. OLEAGINOUS AND RESINOUS DIAPHORETICS.—This group includes a large number of substances, some of which owe their activity to volatile oil, as the Labiatæ and the Lauraceæ (*e. g.* Sassafras and Camphor); others to resin, as Mezereon and Guaiacum; while some contain both oil and resin, as Copaiva and the Turpentines. The substances of this order possess stimulant properties. They probably act locally on the cutaneous vessels through the blood; for some of them (*ex.* Copaiva) can be detected by their odour in the perspiration, and they occasionally excite a slight eruption on the skin. The diaphoretics of this group are useful in chronic rheumatism, secondary syphilis, and chronic cutaneous diseases.

ORDER 6. ALCOHOLIC DIAPHORETICS.—Alcohol and Wine augment cutaneous exhalation.

ORDER 7. IPECACUANHA.—I believe the diaphoretic property of Ipecacuanha to be considerably less than is commonly supposed. Dover's Powder owes its power of producing sweating almost exclusively to the Opium which it contains.

MODUS OPERANDI.—Dr. Edwards[a] has shewn, that cutaneous transpiration is effected in two ways,—by a physical action or evaporation, and by an organic action or transudation. *Evaporation*, or the physical action, is the consequence of the porosity of bodies, and takes place equally in the dead and living state. It is influenced by the hygrometric states of the surrounding air, by its motion or stillness, by its pressure, and by its temperature. Thus, dryness, agitation, and diminution of the weight of the air, increase it. *Transudation*, or the organic action of transpiration, is a vital process, effected by minute spiral follicles or sudoriferous canals, and depends essentially on causes inherent in the animal economy, although it may be influenced to a certain extent by external agents. Thus, elevating the temperature of the surrounding air, preventing its frequent renewal, and covering the patient with warm clothing, are means which promote the organic, but check the physical, action of transpiration. Diaphoretics affect the transudation or the vital process. They probably affect the exhalants in one or both of two ways;—by increasing the force of the general circulation,—or by specifically stimulating the cutaneous vessels.

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[z] See Dr. Osborne's paper in *The Dublin Journal of Medical and Chemical Science*, Jan. 1834.—Also Dr. Christison, *On Granular Degeneration of the Kidnies*. Edinburgh, 1839.

[a] *De l'Influence des Agens Physiques sur la Vie*. Paris, 1824.

SUB-CLASS 3. *DIURETICA.—DIURETICS.*

DEFINITION.—Medicines which promote the secretion of urine are denominated *diuretics* (from δία, *through;* οὖρον, the *urine;* and ῥέω, *I flow*).

PHYSIOLOGICAL EFFECTS.—There are two principal modes of promoting the secretion of urine; the one direct, the other indirect. The *indirect* method consists in augmenting the quantity of fluids taken into the stomach, or in removing any cause which checks the secretion. The *direct* mode is to stimulate the kidneys by means which specifically affect these organs. These means are the diuretics, properly so called. But almost all the substances thus denominated are most inconstant in their effects.

The quantity of urine secreted in the healthy state is liable to considerable variation. Temperature, season of the year, climate, time of day, quantity of fluid consumed as drink, state of health, &c. are among the common circumstances modifying this secretion. Whenever an unusual quantity of aqueous fluid is taken into the system, the kidneys are the organs by means of which the excess is, for the most part, got rid of. If the customary discharge from the skin or lungs be checked, by cold, for instance, the kidneys endeavour to make up for the deficiency of action in the other organs. Thus, in winter and in cold climates, more urine is secreted than in summer and in hot climates. Again, if transpiration be promoted, as by external warmth, the secretion of urine is diminished. Hence when we wish to augment the renal secretion, diluents should be freely administered, and the skin kept cool.

Mr. William Alexander[b] endeavoured to determine, as nearly as possible, the relative powers of different diuretics, and he has given the following tabular views of his results:—

A Table of the different quantities of urine always discharged in an equal time; viz. from nine o'clock in the morning till two o'clock in the afternoon, when an equal quantity of the same liquid was drunk, but with different diuretics, in different quantities, dissolved in it.

	℥	ʒ	℈
By lbj. ʒvijss. simple infusion of bohea tea, standard	15	4	0
By do. with ʒij. of salt of tartar	22	7	2
By do. „ ʒij. of nitre	22	0	0
By do. „ 4 drops oil of juniper	30	3	0
By do. „ ʒj. salt of wormwood	19	7	1½
By do. „ ʒij. Castile soap	19	1	1
By do. „ a teaspoonful of spt. nitr. dulc.	17	6	1½

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[b] *Experimental Essays.* Edinb. 1768.

	℥	ʒ	℈
By lbj. ʒvijss. with 15 drops of tinc. cantharides	16	4	0
By do. „ ʒij. of sal. polychrest	16	3	0
By do. „ ʒss. of uva ursi	16	1	0½
By do. „ ʒj. of magnesia alba	15	5	0
By do. „ ʒij. of cream of tartar	10	2	0½

A Table of the different quantities of urine evacuated in the same space of time, after drinking the same quantity of different liquors.

	℥	ʒ	℈
By lbj. ℥vijss. of weak punch, with acid	21	2	3
By do. „ new cow whey	18	6	0
By do. „ decoct. diuret. Pharm. Edin.	17	5	0
By do. „ London porter	16	7	0
By do. „ decoct. bardan. Pharm. Edin.	14	7	0
By do. „ warm water gruel	14	6	2
By do. „ small beer	13	7	1
By do. „ warm new milk	11	7	0

These tables are to a certain extent useful, but as diuretics act very unequally at different times, and cannot, therefore, be relied on, the value of Mr. Alexander's experiments is considerably diminished.

By augmenting the secretion of urine we diminish the quantity of blood in the blood-vessels, and thus create thirst, and promote absorption from the serous cavities. Hence diuretics are commonly resorted to in dropsical complaints; but they are most uncertain in their operation. Moreover, when they increase the quantity of urine, their influence on the effusion is not always curative. In dropsy, attended with albuminous urine, and which arises from granular degeneration of the kidneys, diuretics have usually been considered objectionable, on account of their stimulant influence over the kidneys. Dr. Christison[c], however, thinks the distrust has been carried too far, and asserts, that they "do not increase the coagulability of the urine in the early stage: in many instances they seem to diminish it." He also suggests that the irritation set up by the diuretic may be of a different kind to that of the disease; and that the one may not possibly increase,—nay, perchance, may diminish, the other. In relieving the effusion and the coma, he thinks them serviceable, and prefers Digitalis and Cream of Tartar to other agents of this order.

Diuretics may be arranged in the following groups:—

ORDER 1. AQUEOUS DIURETICS.—Aqueous drinks promote diuresis indirectly, when the skin is kept cool, as I have before mentioned.

ORDER 2. SALINE DIURETICS—This order consists principally of the Vegetable Salts of the Alkalis; especially Bitartrate and Acetate of Potash. These undergo partial digestion in the system, and are converted into carbonates. Hence they communicate an alkaline quality to the urine. Their supposed influence in the respiratory process has been before alluded to[d]. To this order also belong Nitrate and the Carbonates of the Alkalis.

ORDER 3. SEDATIVE DIURETICS.—To this order belong Digitalis and Tobacco, whose power of reducing the force and frequency of the heart's action has been already referred to[e]. The diuretic effect has been referred, by Dr. Paris[f], to their sedative operation. For as the energy of absorption is generally in the inverse ratio of that of circulation, it is presumed that all means which diminish arterial action must indirectly prove diuretic, by exciting the function of absorption.

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[c] *On Granular Degeneration of the Kidnies*, pp. 138, 149, & 160.
[d] See p. 119.

ORDER 4. BITTER ACRID DIURETICS.—To this order belong Squills, Colchicum, and Common Broom. These agents, in an over-dose, readily occasion vomiting. They owe their activity to an acrid principle, which probably operates, through the circulation, on the renal vessels as a local stimulant or irritant, and in this way proves diuretic. According to my own observations, Common Broom less frequently fails to prove diuretic than most other agents of this class

ORDER 5. OLEAGINOUS ACRID DIURETICS.—To this order belong Juniper, Turpentine, Copaiva, and Cajuputi. The volatile oil probably operates through the blood on the kidneys, as a topical stimulant. Cantharidin, the active principle of Cantharis vesicatoria, is of the nature of volatile oil, and operates in the same way.

ORDER 6. ACID DIURETICS.—The diluted Acids frequently prove diuretic.

ORDER 7. ALCOHOLIC AND ETHERIAL DIURETICS.—Dilute Spirit and Nitric Ether are diuretics.

MODUS OPERANDI.—I have referred to the *modus operandi* of diuretics in speaking of the Orders; and, in a former part of this work[g], I have given a list of the substances which have been detected either unchanged, or more or less changed, in the urine.

SUB-CLASS 4. *ERRHINA.—ERRHINES.*

DEFINITION.—*Errhines* (from ἐν, *in* and ρίν, *the nose*) are medicines which produce an increased discharge of nasal mucus. Substances which excite sneezing are denominated *sternutatories* (*sternutatoria*) or *ptarmics* (from *πταίρω, I sneeze*).

PHYSIOLOGICAL EFFECTS.—All the substances employed as errhines, or sternutatories, are applied to the nose. The liquefacients, when administered by the stomach, augment the secretion of the pituitary membrane as well as of all other secreting organs; and I have several times remarked the increased discharge of mucus from the nose of patients under the influence of Iodide of Potassium, and have detected the smell of Iodine in their handkerchiefs, so that I believe the particles of this substance are thrown off by the mucous membrane of the nose, as well as by other secreting organs.

Most foreign matters when applied to the pituitary membrane promote its secretion, and frequently also occasion sneezing. The latter is a reflex action of the true spinal system; the excitor or incident nerve, by which the impression is conveyed to the medulla oblongata, is the nasal branch of the trifacial nerve. Sugar and the Labiate plants, when reduced to powder, operate as very mild errhines. Euphorbium, Veratrum, and more especially the alkali Veratria, are the most powerful of the order. Tobacco is intermediate. Absorption readily takes place from the pituitary membrane, and I have several times experienced the constitutional effects of Tobacco (such as nausea, giddiness, depression of the muscular power, and disorder of the mental functions), from the use of the moist snuffs (Rappees). The continued employment of snuff injures the sense of smell and alters the tone of the voice. In syphilitic affections of the nose, and where there is a disposition to nasal polypus, the frequent use of errhines may perhaps be injurious. Errhines have been principally employed to relieve chronic affections of the eyes, face, and brain; for example, chronic ophthalmia, amaurosis, headache, &c. They can only be useful on the principle of counter-irritation.

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[e] See p. 176.
[f] *Pharmacologia*, p. 179, 6th ed.
[g] See p. 108.

Schwilgué[h] enumerates the following purposes for which sneezing is excited: to excite respiration when this function is suspended; to promote the expulsion of foreign bodies accidentally introduced into the air-passages; to occasion a general shock at the commencement of dangerous diseases which we wish at once to suppress; to augment the secretion of nasal mucus, and of tears; to favour the excretion of mucus collected in the nasal sinuses; to rouse the action of the encephalon, of the senses, of the uterus, &c.; and to stop a convulsive or spasmodic state of the respiratory apparatus. We should not, however, forget that the concussion occasioned by sneezing is not always free from dangerous results, especially in plethoric habits, and persons disposed to apoplexy, or affected with hernia, prolapsus of the uterus, &c.

The Errhines may be arranged in the following groups:—

ORDER 1. MECHANICALLY-IRRITATING ERRHINES. — To this order Sugar and other inert substances belong.

ORDER 2. THE LABIATE OR AROMATIC ERRHINES.—Sage, Marjoram, Lavender, and other Labiate plants, form mild snuffs when reduced to powder. They are seldom used singly or alone.

ORDER 3. CEREBRO-SPINANT ERRHINES. — To this order belongs Tobacco, which constitutes the basis of ordinary snuff.

ORDER 4. ACRID ERRHINES.—Euphorbium, Veratrum, and Asarum, belong to this order.

ORDER 5. INORGANIC ERRHINES. — Common Salt, Sal Ammoniac, and Subsulphate of Mercury, belong to this group.

SUB-CLASS 5. *SIALOGOGA.—SIALOGOGUES.*

DEFINITION.—Medicines used to augment the salivary discharge are denominated *sialogogues* (from σίαλον, the saliva; and ἄγω, I convey or drive out).

PHYSIOLOGICAL EFFECTS.—Sialogogues are of two kinds: some act topically, others by specific influence over the salivary organs.

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[h] *Traité de Matière Médicale*, t. ii. p. 298.

This, therefore, is the foundation for arranging them in two groups or orders.

ORDER 1. LOCAL SIALOGOGUES.—These are sialogogues which are applied to the mouth. When used in a soft or solid state they are called *masticatories* (*masticatoria*, from *mastico*, to *eat* or *chew*). They act on the mucous follicles of the mouth and the salivary glands. Most solid or soft bodies, when chewed, increase the flow of saliva: thus Wax and Mastic produce this effect. Acrids, however, as Horse-radish, Mezereon, Pellitory of Spain, and Ginger, possess this property in an eminent degree.

In almost all parts of the world masticatories are more or less used. In the East Indies Betel-nuts (the seeds of Areca Catechu) are chewed, with Quicklime and the Betel-leaf (the leaf Piper Betel). The Indians have a notion that these substances fasten the teeth, clean the gums, and cool the mouth[i]. In this country the masticatory commonly employed by sailors is Tobacco.

As the saliva is generally swallowed, masticatories do not confine their action to the mouth, but excite likewise the stomach. Peron[j] was convinced that he preserved his health, during a long and difficult voyage, by the habitual use of the Betel; while his companions, who did not use it, died mostly of dysentery. For habitual use, and as mere sialogogues, mucilaginous and emollient masticatories might be resorted to, but we find that acrids of various kinds have always been preferred. Masticatories, as therapeutic agents, have been principally used either as topical applications, in affections of the gums, tongue, tonsils, salivary glands, &c., or as counter-irritants in complaints of neighbouring organs, as in ear-ache, rheumatism of the pericranium, affections of the nose, &c. The stronger masticatories, as Mustard and Horse-radish, excite an increased discharge of nasal mucus and tears, as well as of saliva and mucus of the mouth.

ORDER 2. SPECIFIC OR REMOTE SIALOGOGUES. — Several substances have had the reputation of producing salivation or ptyalism by internal use. Of these, the preparations of Mercury are the only ones on which much reliance can be placed, and even they sometimes disappoint us. The preparations of Gold, of Antimony, and of Iodine, occasionally have this effect. The continued use of the Hydrocyanic or Nitric Acid has, in several instances, produced salivation. In poisoning by Foxglove the same has been observed. Lastly, nauseants increase the secretion of saliva. Mercurials are given in certain diseases to excite ptyalism, and in some cases it is necessary to keep up this effect for several weeks. It is not supposed that the salivation is the cause of the benefit derived, but it is produced in order that we may be satisfied that the constitution is sufficiently influenced by the medicine.

SUB-CLASS 6. *EXPECTORANTIA.—EXPECTORANTS.*

DEFINITION. — Medicines which promote evacuations from the bronchia, trachea, and larynx, are denominated *expectorants* (from *expectoro*, I expectorate).

PHYSIOLOGICAL EFFECTS.—In the healthy state, the liquids secreted or exhaled by the aërian membrane are got rid of by evaporation and absorption. But when from any circumstance the balance between the two processes of production and removal is destroyed, and an accumulation of mucus takes place, nature endeavours to get rid of it by coughing. Hence some have applied the term expectorant to irritating substances (as Chlorine gas, the vapour of Acetic or of Benzoic acid, &c.), which, when inhaled, produces coughing, as well as an augmentation of secretion. "We provoke cough," says

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[i] Ainslie's *Materia Indica*.

[j] *Voyage aux Terres Australes*. Paris.

Schwilgué[k], "to favour the expulsion of foreign bodies introduced from without into the aërian tube, and especially of liquids; we have recourse to it to favour the expectoration of mucus, of membraniform concretions, and of pus, which have accumulated in the aërian passages, whenever the local irritation is not sufficiently great."

It has been thought by some, that the mucus secreted may be too tough and viscid to admit of its being easily brought up by coughing, and the term expectorant has been applied to those medicines which have been supposed to render it thinner and less viscid. But as Mr. Moore[l] has justly observed, thick phlegm is sometimes more easily expectorated than thin: and if this were not the case, we have no specific means of rendering the phlegm either thicker or thinner. Liquefacients, however, are the agents most likely to effect it. Frequently the term expectorant is applied to substances supposed to increase or promote the secretion of bronchial mucus, and in pharmacological works a long list of medicines, thought to have this effect, is usually given. Most of the agents employed with this view act relatively,—that is, they obviate the causes which checked the healthy secretion. Some are topical agents, as various Gases and Vapours. There are others, however, which, when taken internally, are supposed to affect the aërian membrane in a specific manner, and are beneficially employed in chronic catarrhs. Such are the Balsams, the Oleo-resins, the Fœtid Gums, Squills, &c. Many of the substances which give relief in chronic pulmonary complaints, do not promote, but check, the secretion of bronchial mucus: as the Sulphate of Zinc,—to which Begin[m] adds the Balsams. Yet these agents are usually classed with expectorants; and Dr. Paris[n] makes one class of expectorants to consist of "medicines which diminish the inordinate flow of fluid into the lungs, and render the expectoration of the remainder more easy." In fact, it appears to me that a large majority of the agents used under the name of expectorants, in bronchial and pulmonary affections, are substances which modify the vital activity of the aërian membrane by an alterative influence, and that expectoration is by no means an essential effect of their operation. This appears to be particularly the case with Antimonials, Senega, and Ipecacuanha. Of all classes of the Materia Medica, none are more uncertain in their action than expectorants.

The following is a provisional arrangement of the substances most commonly used as expectorants:—

ORDER 1. VAPOURS OR GASES USED AS TOPICAL EXPECTORANTS. — Chlorine and Ammoniacal Gases; the Vapours of Iodine, of Water, of the Volatile Oils, of Tar, of Benzoic and Acetic Acids; and the Smoke of Tobacco and Stramonium.

ORDER 2. STIMULATING, RESINOUS EXPECTORANTS.—This order includes the Fœtid Gums, the Oleo-resins, and the Balsams.

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[k] *Traité de Matière Médicale,* tom. ii. p. 296.
[l] *An Essay on the Materia Medica.* London, 1792.
[m] *Traité de Thérap,* t. ii. p. 561.
[n] *Pharmacologia.*

ORDER 3. NAUSEATING EXPECTORANTS, as Emetic Tartar, Ipecacuanha, Squills, Garlic, and Senega.

MODUS OPERANDI.—Several of the so-called expectorants become absorbed, and are recognisable by their odour in the breath; as some of the Oleo-resins, Garlic, and Asafœtida. It is probable, therefore, that their influence over the bronchial membrane is by a topical action. Emetina and Emetic Tartar have, according to Magendie[o] and Orfila[p], a specific influence over the lungs, and the lungs of animals killed by these substances are said to present traces of inflammation.

SUB-CLASS 7. *EMETICA.—EMETICS.*

(Vomitoria.)

DEFINITION.—Medicinal agents used for the purpose of provoking vomiting are called *emetics* (from ἐμέω, I vomit), or *vomits.*

PHYSIOLOGICAL EFFECTS. — Usually within twenty or thirty minutes after taking an emetic, a general feeling of uneasiness and nausea comes on. The pulse becomes small, feeble, and irregular; the face and lips grow pale; a distressing sensation of relaxation, faintness, and coldness of the whole system is experienced; the saliva flows copiously from the mouth; the eyes lose their lustre; and the whole countenance appears dejected. These symptoms, which constitute the first stage of vomiting, continue for a variable period, and are followed by the ejection of the contents of the stomach. As soon as actual vomiting commences, the general phenomena are altered: the pulse becomes frequent and full, the temperature of the body increases, and a sweat breaks out on the face and other parts. During the act of vomiting, in consequence of the pressure made on the abdominal aorta, and the interruption to the circulation through the lungs, from the impeded respiration, the blood returns with difficulty from the head, the face swells and becomes coloured, the conjunctiva is turgid and red, the jugular veins are gorged, and tears burst from the eyes. The violent straining is often attended with pain in the head and eyes, and with the involuntary expulsion of the urine and fæces. The matters vomited vary according to circumstances: they may consist of the alimentary substances, bile, &c. contained in the stomach and duodenum previous to the exhibition of the emetic; of the fluids collected by the action of the emetic; and, lastly, of the emetic itself. Sometimes striæ of blood are observed, which usually come from the pharynx. The number of vomitings, and the ease with which they are effected, are liable to considerable variation, arising from the state of the digestive organs, the temperament of the patient, the state of the cerebral functions, &c. When the vomiting has entirely ceased, the patient feels languid, oppressed, and drowsy, and the pulse becomes weak and slow: the exhaustion is sometimes so great as to be attended with fatal consequences. A case of this kind is alluded to by Dr. Paris[q], in which an emetic was imprudently given to a patient in the last stage of phthisis, with the intention of dislodging the pus with which the lungs were embarrassed: syncope was produced, from which the patient never recovered. Among other occasional ill consequences of vomiting may be mentioned comatose affections, uterine or pulmonary hemorrhages, hernia, abortion, suffocation, prolapsus of the uterus, rupture of the abdominal muscles, &c. These effects are produced by the violent muscular exertions which attend the act of vomiting. They suggest cautions as to the use of emetics. Thus, in apoplexy, and some other cerebral affections, or when a tendency thereto exists; in pregnancy, especially when miscarriage is threatened; in prolapsus uteri, hernia, aneurism, &c. the danger to be apprehended from emetics is obvious. The concussion which they excite sometimes dislodges gall-stones.

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[o] *Formulaire.*
[p] *Toxicologie Générale.*

The intensity and duration of the different stages of vomiting have no necessary relation to each other. Thus the Sulphates of Zinc and Copper excite speedy vomiting, with but little nausea;—and are, therefore, preferred as emetics in narcotic poisoning. Tobacco and Tartarized Antimony, on the other hand, produce great nausea and depression of system. Hence, when the depressing effects of emetics are required, as in inflammatory and other diseases, we employ the the last-mentioned emetic[r].

The irritation produced by the exhibition of emetics gives rise to an increased secretion from the mucous follicles of the stomach and duodenum; as is shewn by the thick, filamentous, and viscid matters frequently ejected. We infer, also, that the action of the exhalants must be increased, inasmuch as persons who have taken only a few spoonfuls of emetic liquids sometimes bring up a very considerable quantity of fluid. Darwin mentions a man who vomited six pints of liquid, although he had only swallowed one. Bile is frequently thrown up, either alone or mixed with other fluids; but we must not infer from this that it had existed in the stomach previous to the exhibition of the emetic, for bile is not ordinarily rejected in the first efforts, but only in the subsequent vomitings; and the quantity increases in proportion to the length of time the vomiting continues. Emetics promote the secretion of bile, and probably of the pancreatic juice also. We presume that they likewise augment absorption during the stage of nausea, previously to the act of vomiting, and when the force of the circulation is reduced.

The number of medicinal substances employed as emetics being but few, little benefit can attend any attempt to classify them. There are, however, two modes of arranging them; either into *vegetable emetics* and *mineral emetics;* or into, first, those which seem to possess a specific power of exciting vomiting (as Emetic Tartar), since they induce it, not only when contained in the stomach, but also when thrown into the veins or otherwise introduced into the circulation (*specific emetics*),—and secondly, those (as Mustard) which create vomiting only when taken into the stomach (*topical emetics*)[s].

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[q] *Pharmacologia,* vol. i. p. 163, 6th ed. 1825.

[r] See p. 145.

MODUS OPERANDI.—Vomiting is a reflex spinal act. It may be excited by touching the fauces, velum pendulum palati, &c. In this case the excitor nerve is the trifacial, the branches of which are distributed to these parts. Tickling the back part of the pharynx excites an act of deglutition[t]. Irritation of the stomach, and upper part of the intestines, also produces vomiting. In this case, the pneumogastric and splanchnic nerves act simultaneously, according to Müller[u], in transmitting the irritation. Emetic Tartar causes vomiting, both when taken into the stomach, and when injected into the veins. As its operation is probably alike in both cases, it becomes a question whether, when introduced into the stomach, it must be first taken up into the circulation before it can cause an act of vomiting;—or, when injected into the veins, it acts on the parts engaged in the act of vomiting through the medium of their blood-vessels? I believe the latter is the more probable explanation; because, in the first place, we know that ordinary gastric irritation, where absorption is out of the question, will excite vomiting;—and, secondly, because Müller has found, that lacerating with a needle the nervus splanchnicus of the left side, in the rabbit, will produce contraction of the abdominal muscles. If this opinion be correct, emetics, when introduced into the stomach, affect the medulla oblongata through the excitor nerves (the pneumo-gastric), and the contraction of the muscles necessary to the act of vomiting, is effected by the reflex nerves (the spinal nerves to produce the expiratory efforts, and, according to Dr. Hall, the pneumo-gastric to close the larynx, and open the cardia). When, however, the emetic is introduced into the circulation, it is doubtful "whether its more important action is upon the organs from which the nervous energy for the movements of vomiting are derived, or upon the organs of motion themselves[v]."

The mechanism of the act of vomiting is too exclusively a physiological subject to permit any observations on it in this place. I must refer to the works of Müller and Dr. M. Hall for information concerning it.

SUB-CLASS 8. *CATHARTICA.—CATHARTICS.*

(Purgatives).

DEFINITION.—Medicines which produce alvine evacuations are denominated *Cathartics* (from καθαίρω, I purge).

PHYSIOLOGICAL EFFECTS.—Cathartics cause alvine evacuations by increasing the peristaltic motion of the intestines and by promoting secretions from the mucous lining. The milder purgatives, however, operate principally by their influence on the muscular coat of the intestines; while the stronger ones stimulate the mucous follicles and exhalants, and give rise to liquid evacuations. These are denominated *Hydragogues* (from ὕδωρ, water; and ἄγω, I drive off). Some of them create nausea, faintness, occasionally vomiting, colicky pains, abdominal tenderness, and tenesmus. The more violent ones, if given in an over-dose, produce inflammation of the alimentary canal[w], characterised by violent vomiting and purging, abdominal pain and tenderness, cold extremities, and sinking pulse. These are denominated *Drastics* (from δράω, I am active). Emollient or demulcent drinks (as barley water, gruel, and broth) are taken to favour their safe operation. As the intestinal surface consists of about 1400 square inches[x], from the whole of which secretion and exhalation are going on, it is obvious that purging offers a very powerful means of diminishing the quantity of the fluids of the body; and accordingly we find that some cathartics, especially Elaterium, cause very copious watery discharges; and their employment is followed, as might be expected, with thirst and augmented absorption from the serous cavities, so that they sometimes reduce or even remove dropsical swellings. The more violent purgatives promote the discharge of bile and pancreatic liquor, by the irritation they produce at the termination of the ducts which pour these secretions into the alimentary canal.

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[s] For an account of the uses of emetics consult Dr. Fothergill's Inaugural Dissertation, "*De Emeticorum Usu in variis Morbis tractandis.*" Edinb. 1736.—An English translation of this is published in his *Medical Works*, by J. C. Lettsom, M.D. Lond. 1784.

[t] Dr. Marshall Hall, *On the Diseases and Derangements of the Nervous System*, p. 103. A feather, introduced into the throat to excite vomiting, has, by being pushed too far down, been actually swallowed, without causing vomiting.

[u] *Physiology*, by Baly; vol. i. p. 509.

[v] Müller, *op. supra cit.* p. 510.

A distinction is usually made in practice between *cooling* and *warm* purgatives. By the former are commonly meant saline purgatives which, while they cause purging, without having any tendency to excite inflammation, are supposed to have a refrigerant influence over the system, and are adapted for febrile and inflammatory cases. By the latter are meant the more violent cathartics, which are presumed either to quicken the pulse, or at least to excite the abdominal vascular system, and, therefore, are considered to be less fitted for febrile cases[y].

Cathartics may be conveniently arranged in five groups or orders, as follows:—

ORDER 1. LAXATIVES OR LENITIVES.—This group contains the *mild cathartics*, such as Manna, Cassia pulp, Tamarinds, Prunes, Honey, Bitartrate of Potash, and the fixed Oils (as Castor, Almond, and Olive oils). These very gently evacuate the contents of the intestinal canal, and usually without causing any obvious irritation, or affecting the general system. Manna, however, is apt to occasion flatulence and griping. Laxatives are employed in any cases where we wish to evacuate the bowels with the least possible irritation, as in children and pregnant women; in persons afflicted with inflammation of any of the abdominal or pelvic viscera, with hernia, prolapsus of the womb or rectum, piles, or stricture of the rectum; and after surgical operations about the abdomen and pelvis.

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[w] The deaths from the use of Morison's Pills are referrible to this. The active ingredient of these medicines is gamboge (see *Lond. Med. Gaz.* vol. xiv. p. 612 and 759; vol. xvii. p. 357, 415, and 623; vol. xviii. p. 75 and 927; vol. xix. p. 976.

[x] This measurement has been calculated from the statements as to the length and diameter of the intestines in Meckel's *Manuel d'Anatomie générale, descriptive et pathologique.* Traduit par J. A. L. Jourdan et G. Breschet. Paris, 1825.

[y] An anonymous writer, in the *London Medical Gazette,* vol. iv. p. 139, contends that Aloes is not a warm purgative, though usually considered to be so.

ORDER 2. SALINE, ANTIPHLOGISTIC, OR COOLING CATHARTICS.—This order is composed of the *saline* purgatives, such as the Sulphates of Soda, Potash, and Magnesia, &c. They increase the peristaltic motion of the alimentary canal, and augment the effusion of fluids by the exhalants of the mucous surface, thereby giving rise to watery stools. They do not appear to possess the power of inflaming the intestinal tube, nor of heating the general system. They are adapted for febrile disorders, inflammatory affections, plethoric conditions, &c.

ORDER 3. MILDER ACRID CATHARTICS.—This order includes Senna, Rhubarb, and Aloes. These are more active substances than any of the preceding. They are acrids and stimulants, but their local action is not sufficiently violent to cause inflammation. Senna is employed where we want an active, though not very acrid or irritant, purgative. Rhubarb is administered in relaxed and debilitated conditions of the alimentary canal, on account of its tonic properties. Aloes is used in torpid conditions of the large intestines, and in affections of the head. It is usually considered objectionable in piles and diseases of the rectum.

ORDER 4. DRASTIC CATHARTICS.—This group comprehends the *strong acrid purgatives;* such as Jalap, Scammony, Black Hellebore, Gamboge, Croton oil, Colocynth, and Elaterium. These, when swallowed in large doses, act as acrid poisons. They are employed as purgatives in torpid conditions of the bowels; as hydragogues in dropsical affections; and as counter-irritants in affections of the brain. They are objectionable remedies in inflammatory and irritable conditions of the alimentary canal.

ORDER 5. MERCURIAL CATHARTICS.—The principal of these are the Hydrargyrum cum Cretâ, the Pilula Hydrargyri, and Calomel. We employ them as alterative purgatives, and to promote the hepatic functions. As they are uncertain in their operation, they are usually combined with, or followed by, other purgatives.

MODUS OPERANDI.—The more powerful cathartics are acrids or local irritants. Some of them (*e. g.* Gamboge) operate almost solely in this way; for they do not excite purging except when they are introduced into the alimentary canal, and they easily excite vomiting when swallowed. But most of the drastics exert, in addition, a specific influence over the alimentary canal, so that they excite purging when injected into the veins, or when applied either to the serous membranes or cellular tissue. Senna, Castor and Croton oils, Black Hellebore, Colocynth, and Elaterium, operate in this way. This circumstance, therefore, favours the notion that they act, in part at least, by absorption.

That the purgative principles of some cathartics are absorbed, is quite certain. Gamboge, Rhubarb, Sulphate of Potash, and Oil of Turpentine, have been detected in the blood. Senna, Rhubarb, and Jalap, communicate purgative qualities to the milk. The colouring matters of Cassia pulp, Rhubarb, Senna, and Gamboge, have been recognised in the urine.

Some cathartics act also as diuretics,—as Bitartrate of Potash and Gamboge. Dr. Christison[z] observed, that where diuretics have been given for some time without effect, he has frequently seen their action brought on "by a single dose of some hydragogue cathartic,—such as Gamboge." The resinous particles, in their passage out of the system through the renal vessels, probably acted as topical stimulants.

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[z] *On Granular Degeneration of the Kidnies*, p. 150. Edinburgh, 1839.

Cathartics probably act, in part at least, by a reflex action of the ganglionic system. Müller[a] observes, that galvanising the splanchnic nerve or the cœliac ganglion, gives rise to a generally increased activity of the peristaltic movements, while division neither of the pneumo-gastric nor of the sympathetic nerve, puts a stop to them. This appears to show that the splanchnic nerve is concerned in propagating the irritation set up by cathartics. The tenesmus occasioned by some cathartics is a reflex action of the true spinal system.

Different parts of the alimentary canal are unequally affected by different cathartics. Thus, Aloes is remarkable for its action on the large intestine; moreover, many of the drastic cathartics,—as Gamboge, Colocynth, Savin, and Black Hellebore,—create more irritation in the large, than in the small, intestines; and Orfila[b] mentions, that in animals killed by these substances, he found the stomach and rectum inflamed, while the small intestines were healthy. In some cases, perhaps, this may be ascribed to the rapidity with which these agents pass through the small intestines, and on their longer continuance in the stomach and rectum; but the same appearance has been noticed when these cathartics have been applied to the cellular texture of the thigh.

According to Liebig[c], concentrated saline solutions have a physical, as well as a medicinal, action. They extract water from the coats of the stomach, and thereby create thirst. Part of the solution, thus becoming diluted, is absorbed; but the greater portion enters the intestines, dilutes the solid matters, and thus acts as a purgative.

Sub-class 9. *Emmenagoga.—Emmenagogues.*

Definition.—Medicines which excite or promote the catamenial discharge are termed *emmenagogues* (from ἐμμήνια, the menstrual discharge, and ἄγω, I drive away).

Physiological Effects.—As the suppression or retention of this secretion may be occasioned by very different circumstances, no one agent can be expected to prove emmenagogue in all, or even in many, cases. Deficient menstruation is rarely, perhaps, an idiopathic disease, but usually a morbid symptom merely; and, therefore, those agents which remove it must be relative,—that is, must have reference to the disease which produces it. Thus when deficient menstruation is connected with a deficiency of power in the system, tonics and stimulants are the best remedies. Again, in plethoric habits, bloodletting, and other debilitating agents, are most likely to be serviceable.

But the term emmenagogue is usually employed, in a more limited sense; namely, to indicate those substances which are supposed to possess a specific power of affecting the uterus, and thereby of promoting the catamenial discharge. There are, however, few bodies to which this definition can be strictly applied. Indeed, two reasons have led some pharmacological writers to doubt the existence of any medicines which can be properly termed specific emmenagogues, namely, the uncertainty of all the means so named, and the uterus not being an organ intended for the excretion of foreign matters.

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[a] *Physiology*, by Baly, vol. i. p. 511.

[b] *Toxicologie Générale.*

[c] *Organic Chemistry in its Application to Agriculture and Physiology*, edited by Lyon Playfair, p.534. Lond. 1840.

The substances usually regarded as specific emmenagogues are, for the most part, medicines which, when taken in large doses, act as drastic purgatives. Such are Savin, Black Hellebore, Aloes, Gamboge, &c. They excite the pelvic circulation, give rise to a sensation of bearing down of the womb, especially in females disposed to procidentia uteri, increase uterine hemorrhage, or the menstrual discharge, when given during these conditions,—and when administered in chlorosis or amenorrhœa, sometimes bring on the catamenia. Savin is decidedly the most emmenagogue of all the drastics just mentioned. The most effectual mode of obtaining its uterine influence is by exhibiting its oil.

Substances that irritate the urinary organs also evince a stimulant influence over the uterus. I have known abortion produced by Cantharides given as an emmenagogue.

Rue is a reputed and popular emmenagogue. It possesses cerebrospinant properties, and has on several occasions produced mis carriage.

Madder was a favourite emmenagogue with the late Dr. Home[d], who declared it to be the strongest and safest known. The Fetid Gums and Castoreum have also been supposed to possess a similar property. The Chalybeates are exceedingly valuable remedies in uterine obstructions, attended with an anæmic condition of system. Mercurials, by their liquefacient properties, promote the secretion of the uterus in common with that of other organs.

Ergot of Rye possesses an unequivocal influence over the uterus. But it rather promotes uterine contractions than the menstrual function; though it has, on many occasions, been successfully employed in amenorrhœa.

SUB-CLASS 10. *CHOLAGOGA.—CHOLAGOGUES.*

(Xolotics or Bilitics, *Nuttall.*)

DEFINITION.—Medicines which promote the discharge of bile into the alimentary canal are denominated *Cholagogues* (from χολὴ, bile, and ἄγω, I drive off).

PHYSIOLOGICAL EFFECTS.—It is probable that most, if not all, drastic purgatives increase the secretion and excretion both of bile and pancreatic juice, by irritating the opening of the ductus choledochus in the duodenum, just as certain substances, taken into the mouth, provoke an increased discharge of saliva by irritating the mouths of the salivary ducts. Graaf[e] says, that if a purgative be administered to a dog, and when it is beginning to operate, the abdomen be laid open, the bile and pancreatic juice will be observed flowing into the duodenum.

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[d] *Clinical Experiments,* p. 422, 2d. ed. Lond. 178

The term cholagogue, however, has been more particularly applied to substances which have been supposed to have a specific influence in promoting the secretion or excretion of bile. Mercury, Aloes, and Rhubarb, have been considered to possess this property. The Alkalis are believed, by some, to render the biliary secretion more copious and thinner.

CLASS 7. ECBOLICA.—ECBOLICS, OR CONTRACTORS OF THE UTERUS.

(Abortiva; Amblotica; Acceleratores Partûs.)

DEFINITION.—Medicines which excite uterine contractions, and thereby promote the expulsion of the contents of the uterus, are called *ecbolics* (from *ἐκβόλιον*, a medicine which expels the fœtus).

PHYSIOLOGICAL EFFECTS. — Some medicines excite the vascular system of the uterus, as Savin, and the other Drastic Purgatives. These promote the menstrual discharge, and are, therefore, denominated emmenagogues. But there is another class of agents which excite muscular contractions of the uterus, and, therefore, are adapted for expelling substances (as the fœtus, hydatids, clots of blood, &c.) contained in the uterine cavity. These are the Ecbolics. The only unequivocal agent of this class is Ergot, which appears to operate on the uterus by a reflex action, and will be fully noticed hereafter. Probably the ergot of all grasses acts in the same way. A similar property has been ascribed to Borax.

CLASS 8. ACIDA.—ACIDS.

(Antalkalina.)

DEFINITION.—Acid medicines which, by repeated use, produce a chemical change in the fluids, have been formed into a separate class, under the name of *Acids*.

PHYSIOLOGICAL EFFECTS.—The Mineral Acids, when concentrated, decompose the organic tissues (see p. 104). Swallowed in this state they are corrosive poisons. When sufficiently diluted they cease to be corrosive, though they still exert a chemical influence. Thus, when applied to the skin, they harden the cuticle by uniting with its albumen; and when applied to the mucous surface they produce astriction, and a slight whitening of the part (from their chemical influence). The diluted Mineral and Vegetable Acids, when swallowed in moderate doses, at first allay thirst, sharpen the appetite, and promote digestion. They check preternatural heat[f], reduce the frequency of the pulse, lessen cutaneous perspiration, frequently allay the troublesome itching of prurigo, operate on the solids as tonics[g], and frequently prove diuretic[h]; at the same time that they alter the quality of the urine, which they generally render unusually acid. The milk acquires a griping quality, and the bowels are usually slightly relaxed. Under their long-continued use, the tongue becomes pale and coated with a whitish but moist fur, the appetite and digestion are impaired, while griping and relaxation of bowels, with febrile disorder, frequently occur. If their use be still persevered in, they more deeply injure the assimilative processes, and a kind of scorbutic cachexy is established.

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[e] Barbier, *Traité Elément. de Mat. Méd.* t. iii. p. 1252, 2nde éd.
[f] See p. 192.

Acids are used as caustics, as refrigerants, as tonics, as diuretics, as antalkalines, as antilithics, and to check sweat and pruriginous itching.

Class 9. Alkalina.—Alkaline Medicines.

(Antacida).

Definition.—Alkaline medicines, which by repeated use produce a chemical change in the fluids, have been formed into a distinct class, under the name of *Alkalina*.

Physiological Effects.—The alkalis in a concentrated form are powerful caustics, and when swallowed act as corrosive poisons. From their solvent action on the organic tissues, they have a softening influence even in the dilute form, and, in consequence, are saponaceous to the touch. When taken into the stomach, in the diluted state, they destroy the acid condition of the alimentary canal, and slightly augment secretion. They become absorbed, act as diuretics, and at the same time alter the quality of the urine, to which they communicate an alkaline reaction. By repeated use they operate as liquefacients[i]. Their long-continued employment gives rise to great disorder of the assimilative organs, and a condition analogous to that of scurvy is induced[j]. In such cases it is said that the blood drawn from a vein does not coagulate on cooling. Alkalis are used as escharotics, as antacids, as resolvents, as antiphlogistics[k], as diuretics, and as antilithics.

Lithontriptics; *Antilithics.*—Medicinal agents which effect the solution or disintegration of urinary calculi within the body, are denominated *Lithontriptics* (from λίθος, a stone, and τρίβω, I rub or wear out, or destroy). The long-continued action of large quantities of simple water on urinary calculi is capable apparently of disintegrating, and in some cases of dissolving them[l]. This fact deserves especial notice, since it points out the propriety of aiding the operation of the most powerful lithontriptics by the copious use of water. The medicinal agents, which readily dissolve these concretions out of the body, belong to the two preceding classes, Acid and Alkaline substances. Thus the phosphates readily dissolve in hydrochloric and nitric acids,—while alkaline solutions are solvents for uric acid. But the introduction, by injection, into the bladder of either acid or alkaline solutions, sufficiently strong to exert much chemical influence over calculi, would be attended with dangerous irritation of the vesical coats. And, if we exhibit them by the mouth, they undergo important changes in passing through the system, so that by the time they reach the bladder their chemical influence, as solvents, is in a great measure, if not wholly, destroyed. Yet it cannot be denied that at times they have appeared to give considerable relief, and to act as real lithontriptics. But Dr. Prout [m] asserts that urine, when in a perfectly healthy condition, is one of the most universal as well as powerful solvents we possess for urinary deposits; and as it contains no free and uncombined alkaline or acid ingredient, he concludes that lithontriptics "are to be sought for among a class of harmless and unirritating compounds, the elements of which are so associated as to act at the same time with respect to calculous ingredients, both as alkalis and acids." At present no substance of this kind is known, but the solutions of the supercarbonated alkalis, containing a great excess of carbonic acid, approach the nearest to them; and the mineral waters of Vichy [n], which have long been celebrated in calculous affections, are natural solutions of this kind. The operation of these waters is not confined apparently to their solvent effects; for they possess also a disintegrating power: that is, they disturb "the attraction, both cohesive and adhesive, by which the molecules of calculi are held together, so as to render them brittle and easily broken into fragments."

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[g] See p. 189.

[h] See p. 201.

[i] See p. 194.

[j] See p. 196.

[k] See p. 195.

[l] Chevallier, *Essai sur la dissolution de la gravelle et des calculs de la vessie.* Paris, 1837.—Also *Lond. Med. Gaz.* vol. xx. p. 431.

CLASS 10. TOPICA.—TOPICAL REMEDIES.

DEFINITION.—External remedies, which are used on account of their topical influence, have been formed into a distinct class, under the name of *topica*.

PHYSIOLOGICAL EFFECTS.—This class is a very heterogeneous one, and contains substances which possess a very dissimilar mode of operation. On this, as well as on other grounds, objections may, with great propriety, be made to its admission in a physiological arrangement; and the only apology I can offer for it is that of convenience.

Topical remedies may be conveniently arranged in six orders, as follows:—

ORDER 1. CAUSTICA. *Cauteria Potentialia.*—Topical agents, which disorganise by a chemical action, are called *caustics* (from καίω, I burn). The stronger ones, as Potassa fusa, are called *escharotics*, or *erodents;* the milder ones, as Sulphate of Copper, *catheretics*, or *cauterants*. The general action of these has been already noticed [o]. Some of the substances used as caustics (as Arsenious Acid) become absorbed, and produce constitutional symptoms.

The substances used by surgeons as caustics may be arranged in suborders thus:—

SUBORDER 1. CONCENTRATED NON-METALLIC ACIDS.—As Sulphuric, Nitric, Hydrochloric, Phosphoric, and Acetic Acids.

SUBORDER 2. ALKALIS.—Potassa fusa, Liquor Ammoniæ, and Quicklime.

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[m] *On the Nature and Treatment of Stomach and Urinary Diseases.* Lond. 1840.

[n] Ch. Petit, *Quelques considérations sur la nature de la goutte et sur son traitement par les eaux de Vichy.* Paris, 1835.—*Nouvelles observations de guérisons de calculs urinaires au moyen des eaux de Vichy.* Paris, 1837.

[o] See p. 105.

Suborder 3. Metallic Compounds.—A considerable number of these are used, viz.—

α. Oxides; as Binoxide of Mercury and Arsenious Acid.
β. Chlorides; as the Sesquichloride of Antimony, Chloride of Zinc, and Bichloride of Mercury.
γ. Oxysalts; as Nitrate of Silver, Sulphate and Acetate of Copper.

Caustics are employed for various purposes, the principal of which are the following:—To remove excrescences or morbid growths of various kinds, such as warts, condylomata, some kinds of polypi, and spongy growths or granulations; to decompose the virus of rabid animals, and the venom of the viper and other poisonous serpents; to form artificial ulcers,—as issues; to open abscesses; for the cure of hydrocele they have been applied to the scrotum, so as to penetrate through the tunica vaginalis; to change the condition of ulcerated and other surfaces; lastly, caustics are applied to strictures of the urethra.

Order 2. Topical Stimulants.—These are remedies employed to augment the vital activity of the parts to which they are applied. When they produce irritation or inflammation, they are called *Irritants.* If they be organic substances, and cause local irritation, independently of any known chemical agency, they are denominated *Acrids* [p].

Suborder 1. Cutaneous Stimulants. *Rubefacients, Vesicants,* and *Suppurants.*—These are agents which, when applied to the skin, cause redness, and sometimes vesication and suppuration. The milder ones, such as Friction and Warm Fomentations, stimulate the skin temporarily, without producing actual inflammation. The stronger ones, such as Mustard and Cantharides, excite active inflammation. Those that cause the exhalation of a thin serous fluid beneath the cuticle, are called *vesicants* or *epispastics:* Mustard, Euphorbium, Mezereon, Acetic Acid, Ammonia, and Cantharides, are of this kind; while Tartar Emetic, and some other substances, which produce a secretion of pus, are denominated *suppurants.* The medicines of this class are employed as counter-irritants in various diseases. Their *modus medendi* has been before investigated[q].

Suborder 2. Ulcer Stimulants.—Surgeons employ a variety of topical applications to wounds and ulcers, for the purpose of augmenting or altering the vital activity of the part. Those which promote healthy suppuration are called Digestives (*Digerentia* seu *Digestiva*), as the *Ceratum Resinæ.* Those which are supposed to promote cicatrization are denominated Epulotics (*Epulotica,* from ἐπουλόω, I cicatrize,) or *Cicatrisantia,* as *Ceratum Calaminæ.* Under the name of Detergents (*Detergentia*) are included substances which cleanse wounds, ulcers, &c., and comprehend various kinds of agents; some of which, however, are topical stimulants.

Order 3. Astringents and Desiccants.—Agents which, by their affinity for fibrine and albumen, constrict fibres and coagulate albuminous liquids, are denominated *Astringents.* When employed to check hemorrhage, they are called *Styptics.* The vegetable astringents have been already noticed[r]: they owe their activity to Tannic Acid. A considerable number of mineral substances act as astringents when used in a dilute form,—such as Sulphate of Copper, Nitrate of Silver, Chloride of Zinc, Sulphate of Iron, Acetate of Lead, Alum, &c. In a concentrated state, the same agents are caustics. Some substances, when applied to secreting and exhaling surfaces, check secretion and exhalation, and cause dryness of the parts, but have scarcely any corrugating power on the solids,—as the Oxide of Zinc. These may be termed *Desiccants.*

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[p] See p. 194.
[q] See p. 145.
[r] See p. 188.

ORDER 4. BENUMBERS.—Certain cerebro-spinants are employed as topical anodynes in neuralgia. For example, Aconite, Belladonna, and Opium[s].

ORDER 5. ANTISEPTICS AND DISINFECTANTS. *Antipestifera; Antiputrescents.*—Agents which prevent or are opposed to putrefaction, are called *Antiseptics* (from ἀντί, against, and σήπτος, putrid). Those which destroy miasmata, are denominated *Disinfectants* (from *dis*, which signifies separation, and *infect*).

Putrefaction, properly so called, is a process peculiar to dead organic matter; and means which check or prevent it, act by a physical or chemical agency, and are the *true antiseptics.* They constitute what Guersent[t] denominates *physical antiseptics.* Warmth, air, and water, are the most powerful agents in promoting putrefaction; and their exclusion, therefore, are among the most effective antiseptic means. Thus, Cold, a Vacuum, and Desiccation, are good conservators of dead organic matters. Alcohol, Syrup, Fats, and Volatile Oils, are antiseptics: all act by excluding air, and some of them (*e. g.* Alcohol) likewise by abstracting water from the organic matter. Another class of antiseptics are chemical agents, which form with the organic matters new compounds less susceptible of decay. Saline and metallic solutions, and chlorine, act in this way.

Certain diseases were formerly denominated putrid, and were supposed to depend on a putrescent or decomposed condition of the solids and fluids, characterized by the loose texture of the crassamentum, petechiæ, and an offensive condition of the excretions. Remedies which relieved this state were called antiseptics. Guersent denominates them *physiological antiseptics.* But the alterations which are observed in the characters of the solids and of the blood in the above maladies, have no apparent analogy with those which attend the putrefaction of dead animal matters; and accordingly modern pathologists have rejected the doctrine of putrescency of the fluids. Liebig[u] has endeavoured to revive the old notion; but, though his reasoning is ingenious, it is to me any thing but satisfactory, as I have before (p. 106) remarked. The subject is foreign to the objects of this work, and moreover is too extensive to be further discussed here; but I may remark, in conclusion, that if the effects of the poisons of small pox, plague, syphilis, and decomposing organic matters on the human frame, be denominated fermentation or putrefaction, the meaning of these terms must undergo very considerable alteration and extension.

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[s] See page 175.

[t] *Dictionnaire de Médecine*, art. *Antiseptique.*

[u] *Organic Chemistry in its Application to Agriculture and Physiology.* Edited by Lyon Playfair, Ph. D. London, 1840.

Disinfectants, I have already stated, are agents which destroy miasmata (both odorous and inodorous). Their action is chemical. Chlorine, the Hypochlorites, and Nitrous and Nitric Acids, act either by oxidizing or dehydrogenizing miasmatic matters. The late Dr. Henry[v] has apparently shown, that infectious matter of certain diseases (as scarlatina) is either dissipated or destroyed by a temperature not below 200° F.; and he, therefore, suggested, that infected clothing, &c. may be disinfected on this principle, for he found that neither the texture nor colour of piece goods and other articles of cloathing were injured by a temperature of 250° F. Quicklime absorbs carbonic acid and sulphuretted hydrogen[w] gases, and perhaps other noxious matters. It is, therefore, occasionally useful as a disinfectant; and is employed in the form of wash for the walls of buildings. Ventilation is the most important disinfecting process. To disguise unpleasant odours, fumigations with the Balsamic Resins, Camphor, Cascarilla, and Brown Paper, are sometimes resorted to.

ORDER 6. COSMETICS.—Agents used for the purpose of preserving or restoring the beauty, are denominated *Cosmetics* (*cosmetica,* from *κοσμέω,* I adorn).

The preparation of these substances is usually left to chemists, perfumers, and hairdressers; but the principles on which they are employed come under the consideration of the medical practitioner.

Cosmetics are employed to improve the appearance of the skin, the hair, and the teeth. Hence we make a three-fold division of them:—

α. CUTANEOUS COSMETICS.—Cosmetics are applied to the skin, to soften or harden the cuticle, and to improve the colour and clearness of the complexion.

Alkaline, Oleaginous, and Saponaceous substances, and Soft Water, cleanse and soften the skin. The Alkali acts by its solvent power on the cuticle; Oil has a mechanical influence. Almond and Spanish Soaps, Milk of Roses, and Cold Cream, are the favourite softeners of the skin. Almond Powder is used for a similar purpose.

Diluted Acids, most Saline substances (as Alum) and Alcohol, harden the skin. The acids act by combining with the albumen of the cuticle, and the salts operate, probably, in the same way. The hardening influence of alcohol is connected with its power of coagulating albumen. Hard water indurates by the earthy salts which it holds in solution.

A solution of Bichloride of Mercury in Bitter Almond Emulsion (about gr. j. ad f℥j.) has long been a favourite face-wash: it constitutes Gowland's lotion. Bichloride of Mercury, it is well known, unites with albumen, and hardens animal tissues. Bitter Almonds are mentioned by Celsus[x] as remedies for ephelides (freckles). Withering[y] recommends, as one of the safest and best cosmetics, an infusion of Horse-radish in cold milk.

Face-paints are used to give an artificial colour to the skin: Carmine to communicate a red, and starch-powder a white tint, can produce no injurious effect on the constitution; but the white metallic compounds—viz. Trisnitrate of Bismuth, Carbonate of Lead, and White Precipitated Mercury—are dangerous, as they are liable to become absorbed. Trisnitrate of Bismuth, probably the least injurious of the three compounds just mentioned, has caused spasmodic trembling of the muscles of the face, ending in paralysis[z].

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[v] *Philosophical Magazine and Annals of Philosophy,* for January 1832, vol. xi. pp. 22 & 205.

[w] Chlorine and the Hypochlorites are the most effective agents for destroying sulphuretted hydrogen, which, according to Professor Daniell, is the miasmatic matter of the western coast of Africa. (See p. 83; also, *London Medical Gazette,* July 1841.)

[x] Lib. vi. cap. 5.

[y] *An Arrangement of British Plants,* vol. iii. p. 754, 7th ed. Lond. 1830.

β. HAIR COSMETICS.—Cosmetics are applied to the hair to render it smooth, glossy, and disposed to curl,—to stain it,—to promote its growth,—and sometimes to destroy it.

An excellent pomatum for rendering the hair smooth and glossy, is composed of Olive or Almond Oil ʒiij., and Spermaceti ℥ij. It may be variously scented.

Various substances have, at different times, been recommended for preventing the fall, and promoting the growth, of the hair; but the efficacy of most of them is doubtful. As alopecia, or baldness, arises from various and different causes, it is evident that no one agent can, under all circumstances, prove successful. When the cause is not obvious, the part should be shaved (if any hair be present), and topical stimulants applied, to augment vascular activity. A solution of some Volatile Oil (Rosemary or Thyme), in Rectified Spirit, used as an embrocation, has, at times, appeared to me to be serviceable. Dupuytren[a] employed an ointment composed of ten parts of Tincture of Cantharides (prepared by digesting one part of cantharides in ten parts of rectified spirit), and ninety parts of Hog's-lard.

Depilatories are used to remove superfluous hairs. Lime and Orpiment (Sesquisulphuret of Arsenicum) are the constituents of most of them. Plenck's *pasta epilatoria* consists of one part Orpiment, twelve parts Quicklime, and ten parts Starch, made into soft paste with water. The hair being previously cut close, the paste is applied, and, as soon as the mass is dry, the part is to be washed with water[b]. As orpiment is a dangerous application, especially when the skin is abraded, depilatories are sometimes formed without it. Rayer[c] gives the following formula for one:—Lime, ℥j.; Carbonate of Potash, ℥ij.; Charcoal powder, ʒj.

Hair Dyes have been in use from the most remote periods of antiquity. Medea[d] is said to have been acquainted with the art of dying the hair black. Paulus Ægineta[e] gives several compositions for effecting the same purpose. Various powders, pastes, and liquids, are sold in the shops as hair dyes. Some (as *Orfila's Hair Dye*) are mixtures or compounds of powdered Litharge (oxide of lead) and Lime, in about equal weights, or a little excess of the first ingredient. The mixture is made into a paste with hot water or milk, and applied to the hair for four or five hours, the part being covered (with oil-skin, or, in the absence of this, I have known a cabbage-leaf used), to keep the mixture moist. The water causes the Oxide of Lead to unite with the Lime, forming a plumbite of lime. The lime is useful by removing the fatty matter, while the oxide of lead, reacting on the sulphur contained in the hair, forms a black sulphuret of lead. Others (as *Spencer's Hair Dye*) consist of a solution of Nitrate of Silver; which, however, is objectionable, since it is apt to stain the skin. Hair stained with this salt blackens by exposure to the light, partly by the reduction of the silver and partly by the formation of a black sulphuret of silver. When an immediate effect is required, a solution of Hydrosulphuret of Ammonia is applied to the hair after the Nitrate of Silver, by which the black sulphuret of silver is instantaneously formed. *Hewlett's Hair Dye* is of this kind. Other formulæ for hair dyes have been published[f]. Paulus Ægineta mentions the bark of Green Walnuts. A leaden comb is frequently used for a similar purpose. The lead uniting with the sulphur of the hair, forms the black sulphuret. Dyed hair, especially that stained with nitrate of silver, is dry and crisp. The detection of stained hair is sometimes an object of medico-legal research[g]. Lead may be recognized in hair by boiling the latter in nitric acid, and applying the tests for lead to the nitric solution. To detect silver, the hair must be treated with chlorine, to form chloride of silver, which is soluble in ammonia. From the ammoniacal solution the chloride may be precipitated by nitric acid, and its nature ascertained by the usual means.

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[z] Vogt, *Pharmakodynamik*, Bd. i. S. 288. 2te Aufl.

[a] *London Medical Gazette*, vol. xv. p. 848.

[b] Phoebus, *Handbuch der Arzneiverordnungslehre*, 2er Th. S. 78, 3te Ausg. 1840.

[c] *A Theoretical and Practical Treatise on the Diseases of the Skin*, Eng. Transl. p. 1219, Lond. 1835.

[d] Beloe's Translation of Herodotus, vol. i. p. 382. Lond. 1825.

[e] *The Medical Works of Paulus Ægineta, the Greek Physician*, translated into English, by F. Adams, Esq. vol. i. pp. 237 & 366. Lond. 1834.

[f] *Journal de Chimie Médicale*, tom. ii. p. 250, 2de Sér.

γ. TEETH COSMETICS.—Cosmetics are applied to the teeth to cleanse them, improve their colour, and destroy unpleasant odour.

Dentifrices are usually powders. Tooth powders require to have a certain degree of hardness or grittiness, to enable them to remove the foreign matters adherent to the teeth, but not sufficient to injure the enamel. Pumice powder is rather too gritty for frequent use. Employed occasionally (say once in six or eight weeks) it is very serviceable. Though generally repudiated as a dentifrice, I find it is commonly used by dentists for cleaning teeth. Charcoal and Cuttle-fish bone powder are good detergents. Chalk is somewhat too soft. Ratanhy, Cinchona, and Catechu, are useful astringents. Myrrh is employed partly for its odour. All insoluble powders, however, are more or less objectionable, since they are apt to accumulate in the space formed by the fold of the gum and the neck of the tooth, and thus present a coloured circle. Many tooth-powders are coloured red with Bole Armeniac, to render this circle invisible. The soluble substances which may be used as tooth-powders are Sulphate of Potash, Phosphate of Soda, Bitartrate of Potash, and Common Salt.

Disinfecting and decolorizing tooth-powders, washes, and lozenges, owe their efficacy to Chloride of Lime, and are used to destroy the unpleasant odour of the breath, and restore the white colour of the teeth when stained by tobacco,[h] &c. Thus, one part of Chloride of Lime may be added to twenty or thirty parts of Chalk, and used as a decolorizing tooth-powder. A disinfecting mouth-wash is prepared by digesting three drachms of Chloride of Lime in two ounces of Distilled Water; and, to the filtered solution, adding two ounces of Spirit, to which some scent (as Otto of Roses) has been added.

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[g] Devergie, *Médecine Légale,* t. ii. p. 931. Paris, 1836; and Dr. Cummin, *Lond. Med. Gaz* vol. xix. p. 215.

[h] *Journal de Chimie Médicale,* t. iii. p. 494; and t. iv. p. 28.

Part Second.

PHARMACOLOGIA SPECIALIS.—SPECIAL PHARMACOLOGY.

Special Pharmacology treats of medicines individually. These I shall, for the most part, arrange in Natural-Historical Order.

Natural bodies are divided into two groups, called *Kingdoms;* the *Inorganised* and the *Organised.* The latter is subdivided into two *Sub-Kingdoms,* the *Vegetable* and the *Animal.*

Formerly naturalists admitted three kingdoms; the Mineral, the Vegetable, and the Animal. But the impossibility of so characterising the two latter as to distinguish them from one another, has led later writers to unite them into one kingdom.

Brogniart[i] makes three divisions of bodies,—the *Inorganic,* the *Organic,* and the *Organised.*

I. INORGANISED KINGDOM.

Class I. Non-Metallic Substances.

(Metalloids.—*Berzelius.)*

Order I. OXYGEN, AND ITS AQUEOUS SOLUTION.

OXYGEN'IUM.—OXYGEN.

History, Synonymes, and Etymology.—Oxygen gas was discovered, on the 1st of August, 1774, by Dr. Priestley[k], who denominated it *dephlogisticated air.* In the following year, Scheele also discovered it, without knowing what Priestley had done, and he called it *empyreal air.* Condorcet termed it *vital air.* Lavoisier called it *oxygen,* (from *ὀξὺς, acid;* and *γεννάω, I engender* or *produce*).

Natural History.—Oxygen is found in both kingdoms of nature.

a. In the inorganised kingdom.—Oxygen is, of all substances, that which is found in the largest quantity in nature, for it constitutes at least three-fourths of the known terraqueous globe. Thus, water, which covers about three-fourths of the surface of the earth, contains eight-ninths of its weight of oxygen; and the solid crust of our globe probably consists of at least one-third part, by weight, of this principle; for silica, carbonate of lime, and alumina, the three most abundant constituents of the earth's strata, contain nearly half their weight of oxygen. Mr. De la Beche[l] calculates that silica alone constitutes "forty-five per cent. of the mineral crust of our globe." Of the atmosphere, oxygen constitutes twenty or twenty-one per cent. by volume, or about twenty-three per cent. by weight, to which must be added eight-ninths, by weight, of the atmospheric aqueous vapour.

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[i] *Tableau de la Distribution Méthodique des Espèces Minérales.* Paris, 1833.

[k] *Experiments and Observations on different kinds of Air,* vol. ii. p. 106. Birmingham, 1790.

[l] *Researches in Theoretical Geology,* p. 8. Lond. 1834.

β. IN THE ORGANISED KINGDOM.—Oxygen is an essential constituent of all living bodies. Vegetables, in the sun's rays, absorb carbonic acid, decompose it, retain the carbon, and emit the oxygen. Hence they have been supposed to be the purifiers of the atmosphere.

PREPARATION.—There are several methods of procuring this gas, but I shall notice three only:—

1. *By heating Chlorate of Potash in a green glass retort.*—This method yields pure oxygen gas. (From 100 grains of the chlorate we may expect to obtain nearly 100 cubic inches of the gas.—BRANDE.) One equivalent or 124 parts of chlorate of potash yield six equivalents or 48 parts of oxygen, and one equivalent or 76 parts of chloride of potassium.

MATERIAL.	COMPOSITION.		PRODUCTS.
1 eq. Chlorate of Potash 124	1 *eq. Chloric Acid* 76	5 *eq. Oxygen* .. 40 1 *eq. Chlorine*.. 36	6 eq. Oxygen 48
	1 *eq. Potash* 48	1 *eq. Oxygen* .. 8 1 *eq. Potassium* 40	1 eq. Chloride Potassium 76
	124	124	124

2. *By heating Binoxide of Manganese in an iron bottle.*—This is the cheapest method; and, for ordinary purposes, it yields Oxygen gas sufficiently pure. To remove any carbonic acid, the gas is to be washed with lime-water or a solution of caustic potash. One pound of the commercial binoxide usually yields from 30 to 40 pints of gas: but, from fine samples, 40 to 50 pints may be procured. Two equivalents or 88 parts of pure binoxide yield one equivalent or 8 parts of oxygen, and two equivalents or 80 parts of the sesquioxide of manganese.

MATERIAL.	PRODUCTS.	
2 eq. Binoxide Manganese = 88	1 eq. Oxygen	8
	2 eq. Sesquioxide Manganese..	80
		88

3. *By heating Binoxide of Manganese with about its own weight of Oil of Vitriol in a glass retort.*—The quantity of acid to be employed should be sufficient to form, with the binoxide, a mixture having the consistence of cream. This method is convenient when an iron bottle cannot be procured, or when a small quantity of gas is wanted at a very short notice; but it is not economical. One equivalent or 44 parts of the binoxide yield one equivalent or 8 parts of oxygen, and one equivalent or 36 parts of the protoxide of manganese: the latter substance forms, with an equivalent or 40 parts of anhydrous sulphuric acid, one equivalent or 76 parts of sulphate of the protoxide of manganese.

MATERIALS.	COMPOSITION.		PRODUCTS.	
1 eq. Binox. Manganese 44	1 *eq. Oxygen* . . .	8	1 eq. Oxygen	8
	1 *eq. Protox. Mang.* .	36		
1 eq. Sulphuric Acid		40	1 eq. Sulph^{te}. Protox. Mang.	76
		84		84

PROPERTIES.—It is elastic, colourless, odourless, tasteless, incombustible, but a powerful supporter of combustion. According to Dr. Thomson, 100 cubic inches of this gas weigh, at the temperature of 60° F., and when the barometer stands at 30 inches, 34·60 grains: hence its specific gravity is $1{\cdot}11\dot{1}$; 100 cubic inches of air being taken to weigh 31·1446 grs.—(According to Berzelius and Dulong, the sp. gr. is 1·1026.) Its atomic weight is 8: its atomic volume 0·5; hydrogen being in both cases unity.

1 eq. Oxy. = 8

Characteristics.—If a taper or match be plunged into this gas after the flame has been blown out, but while the wick or charcoal is yet glowing, the flame is instantly reproduced. The only gas likely to be confounded with oxygen in this respect is the protoxide of nitrogen, from which oxygen is distinguished by exploding it with hydrogen. A mixture of one volume oxygen and two volumes hydrogen yields, by explosion, water only; whereas a mixture of one volume of the protoxide of nitrogen with one volume hydrogen yields water and one volume of nitrogen. Moreover, a taper burnt in a jar of oxygen gas yields no brown vapour.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Oxygen gas is essential to the germination of seeds, and to the existence and growth of plants. Edwards[m] says that seeds in germinating decompose water to obtain oxygen. In the shade, vegetables absorb it from the atmosphere, and evolve an equal volume of carbonic acid; while, in the solar rays, the reverse changes take place; carbonic acid being absorbed and oxygen expired. The vigorous growth of plants in inclosed cases, as originally proposed and practised by my friend Mr. N. B. Ward[n], does not invalidate the above statements; since the cases are never completely air-tight, but allow the ingress and egress of air consequent on changes of temperature. The quantity of oxygen required for the growth of some plants, however, appears to be much smaller than was previously supposed.

The effects of pure oxygen gas on germination and vegetation have been examined by Theod. de Saussure[o]. He found that the period of germination is the same in oxygen gas as in atmospheric air, but that seeds evolve more carbonic acid in the former than in the latter[p]. Plants do not thrive so well in an atmosphere of oxygen gas in the shade as in one of common air; they give out more carbonic acid, which is always injurious to vegetation in the shade. When exposed in oxygen gas to the direct rays of the sun, they augment in weight about as much as in atmospheric air[q].

β. On Animals generally.—It is usually asserted that all animals require the influence of oxygen, or rather of air, to enable them to exist: but this assertion cannot be proved in the case of some of the lower animals. Thus intestinal worms seem to dispense with respiration [r]. Some animals, which respire, have no organs especially devoted to this function: in these the cutaneous surface effects respiration; as in the *Polypifera.* In the *Infusoria* the respiratory organs are delicate cilia. Many animals have branchiæ, or gills, for respiration, as some *Mollusca*, some *Annelida*, and Fishes. Leeches respire by subcutaneous sacs, which open externally. The respiratory organs of Insects are ramifying tracheæ. Lastly, the higher classes of animals, as the Mammals, respire by means of lungs. Whenever respiration is effected a portion of oxygen disappears, while a quantity of carbonic acid, nearly equal in volume to the oxygen consumed, is produced.

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[m] *Athenæum*, Feb. 2d, 1839.

[n] *Companion to the Botanical Magazine, for May*, 1836.

[o] *Recherches Chimiques sur la Végétation.* Paris, 1804.

[p] See pp. 11 and 12.

[q] See p. 93, *op. cit.*

The continued respiration of oxygen gas is injurious, and even fatal to animal life: this has been observed by all experimenters. Animals live longer in a given volume of oxygen than in the same quantity of atmospheric air, but the continued employment of it causes death. Mr. Broughton confined rabbits, guinea-pigs, and sparrows, in glass jars containing oxygen, and inverted over water. At first they suffered no inconvenience, but in about an hour their breathing became hurried, and the circulation accelerated. This state of excitement was followed by one of debility; the respirations became feeble, and were more slowly performed; loss of sensibility and of the power of voluntary motion supervened, till the only remaining visible action was a slight one of the diaphragm, occurring at distant intervals. On opening the body, the blood (both venous and arterial) was found to be of a bright scarlet hue; it was thin, and rapidly coagulated. The gas in which animals had thus been confined till they died, retained its power of rekindling a blown-out taper, and of sustaining, for a time, the life of another animal introduced into it; and Mr. Broughton hence deduced the inference that it does not contain so great an excess of carbonic acid as the gas left when animals have perished by confinement in atmospheric air, and he considered the train of symptoms induced by the respiration of pure oxygen gas as analogous to those which follow the absorption of certain poisons into the system [s]. Injected into the pleura, oxygen gas is very quickly absorbed, without producing inflammation. Cautiously injected into the veins of dogs, it has no sensible effect on the system [t].

γ. *On Man.*—If pure oxygen be inspired a few times it does not produce any remarkable phenomena; though some have ascribed various effects to it, such as agreeable lightness in the chest, exhilaration, increased frequency of pulse, a sensation of warmth in the chest, gentle perspiration, and an inflammatory state of the system. But several of these results arise probably from mental influence, others from the mode of inhaling the gas, and perhaps some might depend on the employment of impure oxygen.

USES.—Soon after the discovery of oxygen, the most exaggerated notions prevailed as to the remedial powers of this agent. Various diseases (scorbutus, for example) were thought to be dependent on a deficiency of it in the system; and it was, in consequence, submitted to a considerable number of trials, with, as it was at first asserted, remarkable success. But Chaptal[r] and Fourcroy[s] declared that it was injurious in phthisis. In England it was tried by Beddoes[t] and and Hill[u]. The latter states that he found it beneficial in asthma, debility, ulcers, gangrene, white swelling, and scrofulous diseases of the bones. The beneficial results obtained by the use of acids (especially nitric acid), of the oxides of mercury, chlorate of potash, vegetable food, &c. were referred to the oxygen which these substances contained, and which they were supposed to communicate to the system. These notions are now exploded[v].

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[r] Müller's *Physiology*, by Baly, vol. i. p. 295.
[s] *London Medical Gazette*, vol. iii. p. 775.
[t] Nysten, *Recherches de Physiologie*, p. 60. Paris, 1811.

In asphyxia arising from a deficiency of atmospheric air, or from breathing noxious vapours, the inhalation of oxygen gas has been said to be, and probably is, useful. On the same principle, it may be employed during an attack of spasmodic asthma, when there is danger of suffocation; but it is at best only a palliative, and has no power of preventing the occurrence of other attacks. Chaussier[w] has recommended its use in children apparently still-born; I have known it used without benefit. To combat the asphyxia of malignant cholera, inhalations of oxygen were tried in Russia, Poland, Prussia, and France, but without success[x]. On the whole, then, I believe oxygen to be almost useless as a remedy[y].

AQUA OXYGENII. *Oxygen Water.*—At the mean pressure and temperature of the atmosphere, 100 vols. of water dissolve, according to Dalton and Henry[z], 3·7 vols. of oxygen gas; according to Saussure[zz], 6·5 vols. By pressure in a proper machine, water may be charged with a much larger quantity. This solution has been termed *oxygenated water*, but is a very different substance to the peroxide of hydrogen, which has also been known by this appellation. Neither is it to be confounded with Searle's *oxygenous aërated water*, which is an aqueous solution of the protoxide of nitrogen. It has been used to the extent of one or two bottlefuls daily, as a slight excitant. It is said to increase the appetite and promote the secretions; and to be serviceable in spasm of the stomach, amenorrhœa, hysteria, atonic dropsy, &c.

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[r] *Annales de Chimie*, t. iv. p. 21.

[s] Ibid. t. iv. p. 83.

[t] *Considerations on the Medicinal Use of Factitious Airs, and on the Manner of obtaining them in large Quantities.* By T. Beddoes and James Watt. Bristol, 1794-95.

[u] *Practical Observatious on the Use of Oxygen, or Vital Air, in the Cure of Diseases.* Lond. 1800.

[v] For further details respecting these opinions, see the *Dictionnaire Universel de Matière Médicale et de Thérapeutique Général*, par F. V. Mérat and E. J. De Lens, t. v. p. 136.

[w] *Histoire et Mémoires de la Société Royale de Médecine*, 1780-81; *Hist.* p. 346.

[x] Mérat and De Lens, *op. supra cit.* t. v. p. 141.

[y] It is remarkable that Electricity and Oxygen, two agents of vast influence in nature, should possess but slight remedial power.

[z] *Elements of Experimental Chemistry*, vol. i. p. 275, 10th edit. London, 1826.

[zz] *Ibid.*

ORDER II.—CHLORINE, AND ITS COMBINATIONS WITH OXYGEN.

CHLORIN'IUM.—CHLORINE.

HISTORY, SYNONYMES, AND ETYMOLOGY.—This gas was discovered by Scheele in 1774, who termed it *dephlogisticated muriatic acid.* Berthollet, in 1785, named it *oxygenated muriatic acid.* Sir H. Davy called it *chlorine* (from *χλωρὸς, green*), on account of its colour.

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM it exists principally in combination with sodium, either dissolved in the water of the ocean or forming deposits of rock salt. Chlorine also occurs in combination with magnesium, calcium, lead, silver, &c. Free hydrochloric acid is met with in the neighbourhood of volcanoes, and is probably produced by the decomposition of some chloride.

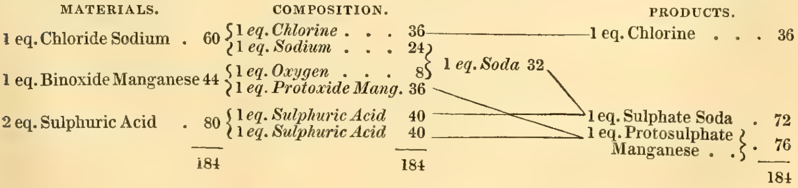
β. IN THE ORGANISED KINGDOM it is found, in combination, in both animals and vegetables. Sprengel[a] says, maritime plants exhale chlorine, principally during the night. Hydrochloric acid, in the free state, exists, according to Dr. Prout, in the stomach of animals during the process of digestion.

PREPARATION.—There are several methods of procuring chlorine gas:—

1. *By adding Diluted Sulphuric Acid to a mixture of Common Salt and Binoxide of Manganese.*—This is the cheapest and most usual method of preparing it. Mix intimately three parts of dried common salt with one part of the binoxide of manganese, and introduce the mixture into a retort. Then add as much sulphuric acid, previously mixed with its own weight of water, as will form a mixture of the consistence of cream. (Brande directs 8 salt, 3 manganese, 4 water, and 5 acid;—Thenard, 1½ salt, 1 manganese, 2 acid, and 2 water;—Graham, 8 salt, 6 manganese, and dilute acid as much as contains 13 parts of oil of vitriol.)

On the application of a gentle heat, the gas is copiously evolved, and may be collected over either warm or cold water[b].

In this process two equivalents or 80 parts of sulphuric acid react on one equivalent or 44 parts of the binoxide, and on one equivalent or 60 parts of chloride of sodium, and yield one equivalent or 36 parts of chlorine, one equivalent or 76 parts of the sulphate of the protoxide of manganese, and one equivalent or 72 parts of the sulphate of soda.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Chloride Sodium . 60
1 eq. Chlorine . . . 36
1 eq. Sodium . . . 24
1 eq. Binoxide Manganese 44
1 eq. Oxygen . . . 8
1 eq. Protoxide Mang. 36
1 eq. Soda 32
2 eq. Sulphuric Acid . 80
1 eq. Sulphuric Acid 40
1 eq. Sulphuric Acid 40
184
184
1 eq. Chlorine . . . 36
1 eq. Sulphate Soda . 72
1 eq. Protosulphate Manganese . . . 76
184

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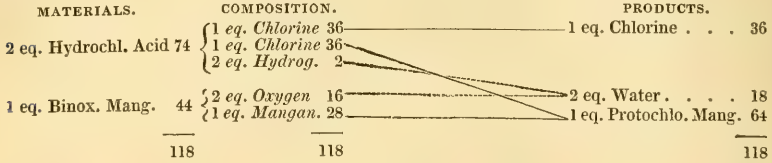
[a] De Candolle, *Physiol. Vég.* tom. i. p. 220.

[b] For further information respecting the commercial mode of preparing chlorine, see *Hypochlorite of Lime.*

2. *By heating a mixture of equal weights of common Hydrochloric Acid and Binoxide of Manganese in a glass retort over a lamp.*

In this process two equivalents or 74 parts of hydrochloric acid react on one equivalent or 44 parts of the binoxide, and yield one equivalent or 36 parts of chlorine, two equivalents or 18 parts of water, and one equivalent or 64 parts of protochloride of manganese.



3. *By the action of Hydrochloric Acid on Chloride* [*Hypochlorite*] *of Lime.*—This method may be resorted to when binoxide of manganese cannot be procured. The products of the reaction of the ingredients are, chlorine, water, and chloride of calcium.

Properties.—Chlorine, at ordinary temperatures and pressures, is a gaseous substance, having a yellowish-green colour, a pungent, suffocating odour, and an astringent taste. 100 cubic inches weigh, according to Dr. Thomson, 77·8615 grs.; and its sp. gr., therefore, is 2·5 [2·47, Berzelius]. Its equivalent by weight is 36[c] [35·47 Berz.; 35·42 Turner] by volume 1; hydrogen being unity. It is not combustible, but is a supporter of combustion. Phosphorus and powdered antimony take fire spontaneously when introduced into it; and a taper burns in it, with the evolution of a red light and much smoke. When water is present it destroys vegetable colours, organic odours, and infectious matters.

1 eq.
Chlorine
= 36

By a pressure of 4 atmospheres, at the temperature of 60° F., chlorine is a yellow liquid, having a sp. gr. of 1·33 (water being 1·).

Characteristics.—The colour, odour, and bleaching property of chlorine readily distinguish it from other gases. It forms a white, curdy precipitate (*chloride of silver*) with the nitrate of silver: this precipitate blackens by exposure to light, from the escape of a little chlorine, and the formation of a subchloride of silver[d]; is insoluble in nitric acid, cold or boiling; readily dissolves in liquid ammonia; when heated in a glass tube fuses, and, on cooling, concretes into a grey, semi-transparent mass (*horn silver*, or *luna cornea*); and, lastly, when heated with potash, it yields metallic silver, and a chloride of potassium. An aqueous solution of chlorine dissolves leaf-gold. The soluble *chlorides* react, as free chlorine, on the solution of nitrate of silver. They evolve hydrochloric acid (which also reacts on a solution of silver) when heated with liquid sulphuric acid. If a watery solution of a chloride, coloured blue by sulphate of indigo, be submitted to the action of a galvanic battery, the chlorine is evolved at the anode or positive pole, and destroys the colour of the sulphate of indigo in its immediate neighbourhood.

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[c] See Mr. R. Phillips's experiments in the *Philosophical Transactions*, for 1839.
[d] Wetzlar, in Landgrebe's *Versuch über das Licht*, p. 53, 1834.

The *chlorates* when heated evolve oxygen, and are converted into chlorides. When mixed with strong sulphuric acid they become orange-red, and give out chlorous acid. They do not precipitate the salts of silver.

The *hyperchlorates* evolve oxygen, and are converted into chlorides when heated. They do not become red, or give out chlorous acid by the action of sulphuric acid. The soluble hyperchlorates precipitate the salts of potash.

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—The germination of seeds has been said to be promoted by watering them with a weak solution of chlorine[e]; but the statement is, probably, erroneous.

β. On Animals generally.—Nysten[f] injected a small quantity of chlorine gas into the jugular vein of a dog, and the only effect was howling. A larger quantity occasioned difficult respiration, apparently great agony, and death in three minutes. The body was opened four minutes afterwards: the blood was fluid and venous in the auricles and ventricles, which contained neither gas nor coagula. On another occasion he threw this gas into the pleura, and thereby produced inflammation of this membrane, and death. From these experiments, Nysten[g] concludes that it is a local irritant, but has no specific effect on any part of the system.

γ. On Man.—Chlorine gas acts as a *local* irritant. Mr. Wallace[h] tells us, that diluted with air, or aqueous vapour, of 116° F., and applied to the skin, it produces peculiar sensations, similar to those caused by the bite or sting of insects: this effect is accompanied with copious perspiration, and a determination of blood to the skin, sometimes attended with an eruption of minute papulæ, or even vesicles. Applied to the skin in a pure form, its action is similar, but more energetic.

If an attempt be made to inspire undiluted chlorine gas, it produces spasm of the glottis. If the gas be mixed with air, it enters into the bronchial ramifications, causes a sensation of tightness and suffocation, and violent cough. Twice I have suffered most severely from the accidental inhalation of it; and each time it gave me the sensation of constriction of the air-tubes, such as might be produced by a spasmodic condition of the muscular fibres of the bronchial tubes. The attack usually goes off in increased secretion from the mucous membrane. When diluted with a large quantity of air, chlorine may be inhaled without exciting cough: it occasions a sensation of warmth in the respiratory passages, and promotes expectoration.

The irritating effects of chlorine are less powerful on those accustomed to inhale it; as I have repeatedly seen in patients who were using the gas, and which is also proved by the following statement, made by Dr. Christison[i]:—"I have been told (says he), by a chemical manufacturer at Belfast, that his workmen can work with impunity in an atmosphere of chlorine, where he himself could not remain above a few minutes."

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[e] De Candolle, *Physiologie Végétale*, t. ii. p. 632.

[f] *Recherches*, p. 140.

[g] *Op. cit.* p. 143.

[h] *Researches respecting the Medical Powers of Chlorine, particularly in Diseases of the Liver.* Lond. 1822.

The constitutional or *remote* effect caused by inhalations of chlorine, is increased frequency of the pulse and of respiration. But this effect may be in part owing to the augmented muscular efforts of the patient. Mr. Wallace states, that the application of chlorine to the skin also occasions soreness of the mouth, fauces, and œsophagus, increased vascularity, and even minute ulcerations of these parts, and an alteration in the quantity and quality of the salivary and biliary secretions. He thinks that it has a tranquillizing, and at the same time exciting, power, with respect to the nervous system. It would appear, from the observations of Professor Albers[j], that though the topical action of chlorine is stimulating, yet the remote action is antiphlogistic; for it diminished the frequency of the pulse, calmed excitement, and produced effects which may be termed antiphlogistic. Dr. Christison tells us, that at the Belfast manufactory above alluded to, the chief consequences of exposure to an atmosphere of chlorine, are acidity and other stomach complaints, which the men generally correct by taking chalk. Absorption of fat is also an effect observed in the manufactories at Glasgow, Manchester, and Belfast[k].

When applied to the skin or bronchial membrane, chlorine gas, probably, becomes absorbed; for Mr. Wallace found that the urine acquired bleaching properties under its use.

USES.—*a. As a fumigating agent, disinfectant, and antiseptic*, chlorine, I believe, stands unrivalled. Hallé, in 1785, appears to have been the first person who employed it as a disinfectant; but we are greatly indebted to Guyton-Morveau for the zeal and energy he manifested in his attempts to introduce it into use. For destroying miasmata, noxious effluvia, and putrid odours, it is the most powerful agent known; and is, therefore, well adapted for disinfecting prisons, ships, hospitals, dissecting-rooms, and all other places, the air of which requires purification. The best method of fumigating a large building is that adopted by Dr. Faraday, at the General Penitentiary at Milbank[l]. One part of common salt was intimately mixed with one part of the black or binoxide of manganese; then placed in a shallow earthen pan, and two parts of oil of vitriol, previously diluted with two parts by measure of water, poured over it, and the whole stirred with a stick. Chlorine continued to be liberated from this mixture for four days. The quantities of the ingredients consumed were 700 lbs. of common salt, 700 lbs. of binoxide of manganese, and 1400 lbs. of sulphuric acid. The disinfecting power of chlorine is supposed to depend on its affinity for hydrogen, by which it effects the decomposition of water or aqueous vapour, with the hydrogen of which it unites, while the nascent oxygen oxidizes the organic matter: or it may act merely by abstracting hydrogen from the putrid miasmata. Chlorine fumigations should be plentifully employed on board of ships off the Western coast of Africa, to prevent the deleterious effects of the miasm, which, according to Professor Daniell, is sulphuretted hydrogen[m].

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[i] *Treatise on Poisons*, p. 736.

[j] *British and Foreign Med. Review*, vol. iv. p. 212.

[k] *An Experimental Essay on the relative Physiological and Medicinal Properties of Iodine and its Compounds.* By C. Cogswell, A.B., M.D. Edinb. 1837, p. 82.

[l] *Quarterly Journal of Science and the Arts*, vol. xviii. p. 92.

β. *As an antidote in poisoning by hydrocyanic acid, sulphuretted hydrogen, or hydrosulphate of ammonia,* chlorine gas is a very valuable agent. I believe, however, that chloride of lime will be found a more convenient, safe, and opportune substance. The beneficial influence of chlorine in the treatment of animals asphyxiated by sulphuretted hydrogen, doubtless arises in part at least from its chemical properties; for when mixed with sulphuretted hydrogen, it forms chloride of sulphur and hydrochloric acid. The best method of applying the remedy is to diffuse a little chlorine in the air, and then to effect artificial respiration.

γ. *Inhaled in chronic pulmonary diseases* it is sometimes a useful remedy. I have carefully watched its effects in phthisis and chronic bronchitis; and the result of my observation is, that chlorine is rarely serviceable. Frequently, after the first and second inhalations, the patients fancy their breathing much relieved, but the amendment is seldom permanent. I need hardly say it has no pretensions to the cure of tubercular phthisis, but it may be useful as a palliative (sometimes diminishing the sweating); and I can readily believe that occasionally in ulceration of the lungs it may be, as Albers[n] declares it is, of essential service. This would agree with the effects observed, in surgical practice, of solutions of chlorine and of the hypochlorites on old ulcers.

I have before described the mode of administering the gas[o]. Either the aqueous solution of chlorine, or a small portion of the chloride of lime, may be placed into the inhaling bottle: if the latter be not sufficiently strong, a few drops of muriatic acid are to be added, to develope free chlorine.

δ. *In diseases of the liver,* not attended with active inflammation, Mr. Wallace has successfully employed gaseous chlorine, either in the pure state or diluted with air or aqueous vapour. The benefit of chlorine in these cases has been confirmed by others. The temperature of the bath, and the time the patient ought to remain in it, will vary in different instances; but Mr. Wallace thinks, that, in the greater number, 150° F. will be found to answer best, and the proper time about half an hour. The benefit obtained is in part referrible to the heat employed, in part to the irritant effect of the chlorine on the skin, and (according to Mr. Wallace), in part to the specific influence of chlorine on the liver[p]. Ziese, an apothecary at Altona, has also employed chlorine baths in these cases with advantage.

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[m] See p. 83.—Also *Lond. Edinb. and Dub. Philosophical Magazine,* for July 1841; and *Lond. Med. Gaz.* for July 16th and 23d, 1841.

[n] *British and Foreign Medical Review,* vol. iv. p. 212.

[o] See p. 51.

Antidotes.—The inhalation of ammoniacal gas, of the vapour of warm water, of the spirit of wine, or of ether, has been recommended, to relieve the effects of chlorine. I tried them all when suffering myself, but without the least apparent benefit. In a case related by Kastner, and which is reported in Wibmer's work[q], sulphuretted hydrogen gave great relief. If this agent be employed, it must be done cautiously, as it is itself a powerful poison.

AQUA CHLORINII, Ph. Dub. *Chlorinei Aqua*, Ph. Ed. — *Solutio Chlorinii; Chlorine Water; Aqua Oxymuriatica; Liquor Chlori; Liquid Oxymuriatic Acid.* — This is readily prepared by passing chlorine gas (prepared as above directed) through water placed in a Woulfe's bottle. The gas may be generated in a clean Florence flask, to which a curved tube is adapted by means of a cork. The receiving vessel holding the water, may be, in the absence of a double-necked bottle, a six- or eight-ounce phial; or a wide-mouthed bottle closed by a cork having two perforations, through one of which passes a glass tube open at the top, and dipping into the water beneath; while through the other passes the end of the tube conveying the gas from the flask into the water.

In the *Dublin Pharmacopœia* the proportions of ingredients used are, Dried Muriate of Soda, 100 parts; Oxide of Manganese, 30 parts; Sulphuric Acid, 87 parts; Water, 124 parts. The gas is to be gradually evolved from this mixture, contained in a retort, and transmitted through 200 parts of Distilled Water.

In the *Edinburgh Pharmacopœia* the process is somewhat different. Muriate of Soda, 60 grs., and Red Oxide of Lead, 350 grs., are to be triturated together; then put into f℥viij. of Water, contained in a bottle with a glass stopper; afterwards the Acid added, and the mixture agitated until all the Red Oxide becomes white. The insoluble matter is to be allowed to subside before using the liquid. In this process, Chlorine and Sulphate of Soda are formed in solution, and White Sulphate of the Protoxide of Lead is precipitated. The sodium of the common salt is oxidized by the nascent oxygen evolved by the red lead, in consequence of the action of the sulphuric acid on it. This process has been contrived to obviate the necessity of having to pass the gas through water, the apparatus for which operation might not be at hand.

In the *Pharmacopœia Nosocomii Middlesexensis*, Lond. 1841, is the following formula for a solution of chlorine:— ℞. Potassæ Chloratis ʒij. Acidi Hydrochlorici, Aquæ destillatæ, āā. f℥ij. Misce. ℞. Hujus Solutionis fʒiij. Aquæ destillatæ f℥xij. Misce.—This solution contains besides chlorine, some chloride of potassium.

Properties.—At the temperature of 60° F. and when the mercury in the barometer is standing at 30 inches, water takes up about twice its bulk of chlorine gas (Gay-Lussac). The solution has a greenish yellow colour, the strong and peculiar odour of the gas, and an astringent taste. Its sp. gr. is 1·003. It bleaches vegetable colours—as tincture of litmus, turmeric, &c. By exposure to light, the water is decomposed, the oxygen is evolved, while the hydrogen unites with the chlorine to form muriatic acid. Hence the solution should be kept in bottles excluded from the light. Prepared according to the Edinburgh Pharmacopœia, the liquid holds in solution a little sulphate of soda, and deposits a white insoluble sulphate of lead.

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[p] For a sketch of the apparatus used, see *Lancet*, vol. i. for 1831-32, p. 859.

[q] *Die Wirkung der Arzneim. u. Giftc.* 2er Bd. S. 109. München, 1832.

Characteristics.—Its odour, its action on a solution of nitrate of silver (as before described for chlorine gas), its power of dissolving leaf-gold, and its bleaching properties, readily distinguish this solution. It destroys the blue colour of iodide of starch and of sulphate of indigo. A piece of silver plunged into it is immediately blackened.

Physiological Effects.—In a concentrated form, the aqueous solution of chlorine acts as a corrosive poison. Somewhat diluted it ceases to be a caustic, but is a powerful local irritant. Administered in proper doses, and sufficiently diluted, it operates as a tonic and stimulant. The continued use of it causes salivation. Applied to dead organic matter it operates as an antiseptic and disinfectant.

Uses.—Chlorine water has been employed in medicine both as an external and internal remedy.

α. *Externally.*—It has been used, in the concentrated form, as a caustic application to wounds caused by rabid animals; diluted, it has been employed as a wash in skin diseases (itch and porrigo); as a gargle in putrid sore-throat; as a local bath in liver diseases; and as an application to cancerous and other ulcers attended with a fetid discharge. In the latter cases I have repeatedly employed it with advantage, though I give the preference to a solution of the chloride [hypochlorite] of soda.

β. *Internally.*—It has been administered in those diseases denominated putrid; for example, in the worst forms of typhus, in scarlet fever, and in malignant sore throat. It has also been employed in venereal maladies, and in diseases of the liver.

Dose.—The dose of this solution varies with the degree of concentration. I have frequently allowed patients to drink, *ad libitum*, water, to which some of this solution has been added. If made according to the directions of the Dublin Pharmacopœia, the dose is from one to two drachms, properly diluted.

Antidotes.—According to Devergie[r], the antidote for poisoning by a solution of chlorine is albumen. The white of egg, mixed with water or milk (the caseum of which is as effective as the albumen of the egg), is to be given in large quantities. The compound, which albumen forms with chlorine, has little or no action on the animal economy, and may be readily expelled from the stomach. In the absence of eggs or milk, flour might be exhibited; or, if this cannot be procured, magnesia or chalk. The gastro-enteritic symptoms are, of course, to be combated in the usual way.

COMPOUNDS OF CHLORINE AND OXYGEN.

None of these are used in medicine. The concentrated aqueous solutions of all of them are oxidizing agents, and act on the organic tissues as caustics.

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[r] *Médecine Légale,* t. ii. p. 634. Paris, 1836.

Their remote effects are probably similar to the acids generally and chlorine. *Hypochlorous* (Cl. + O) and *Chlorous* (Cl. + 4 O) *Acids* are bleaching agents: to the first, the substances called Chloride of Lime and Chloride of Soda owe their disinfecting properties. *Chloric Acid* (Cl. + 5 O) has great analogy with nitric acid; combined with potash it constitutes Chlorate of Potash. *Perchloric Acid* (Cl. + 7 O) is an excellent test for potash.

ORDER III.—IODINE, AND ITS COMBINATIONS WITH OXYGEN AND CHLORINE.

IODIN'IUM, *L. D.*—IODINE.

(Iodineum, *E.*)

GENERAL HISTORY.—Iodine was discovered in 1811 by M. Courtois, a saltpetre manufacturer at Paris. It was first described by Clement in 1813, but was afterwards more fully investigated by Davy and Gay-Lussac. It was named *iodine*, from ἰώδης, *violet-coloured;* on account of the colour of its vapour.

NATURAL HISTORY.—It exists in both kingdoms of nature[s].

α. IN THE INORGANISED KINGDOM.—Vauquelin met with iodide of silver in a mineral brought from Mexico, and Mentzel found iodine in an ore of zinc which contained cadmium. It has also been met with in an ore of lead[t]. It is said to have been found in coals[u]. In sea-water it has likewise been discovered, where it probably exits as an iodide of sodium or of magnesium. Many mineral waters contain it. It was detected by Mr. Copeland[v] in the carbonated chalybeate of Bonnington. About one grain of iodine was found by Dr. Daubeny[w] in ten gallons of the water of Robin's Well at Leamington, in Warwickshire. In the old well at Cheltenham the quantity was not more than one grain in sixty gallons. In a brine-spring at Nantwich, in Cheshire, there was about a grain of iodine in twelve gallons. In the sulphurous water of Castel Nuovo d'Asti, iodine was discovered by Cantu. In some of the mineral waters of Germany, Bavaria, and South America, it has also been detected[x]. Fuchs found it in the rock-salt of the Tyrol[y].

β. IN THE ORGANISED KINGDOM.—Of Animals containing iodine I may mention the genera *Spongia*, *Gorgonia*, *Doris*, *Venus*, &c.: likewise *Sepia*, the envelopes of the eggs of which contain it. An insect has been found near Ascoli, in Italy, which Savi has described under the name of *Julus fœtidissimus*, containing iodine. The animal emits, when disturbed, a yellow fluid strongly smelling of iodine, and which immediately strikes the characteristic violet colour with starch[z]. Recently iodine has been detected in the oil of the cod's liver[a]. A very considerable number of Vegetables, particularly those belonging to the family Algæ, yield it. The following are some instances: *Fucus vesiculosus*,

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[s] Since the publication of the first edition of this work, I have met with S. E. Sarphati's *Commentatio de Iodio*, Lugduni, 1835, which contains the most extensive list of natural bodies containing iodine, of any work with which I am acquainted.

[t] *Journ. de Pharmacie*, tom. xxiii. for 1837, p. 29.

[u] *Lond. and Edinb. Philosoph. Mag.* for Nov. 1839.

[v] *Edinburgh New Philosophical Journal*, vol. i. p. 159.

[w] *Phil. Trans.* 1830, Part 2, p. 223.

[x] Gairdner, *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs*, p. 27, Edinb. 1832.

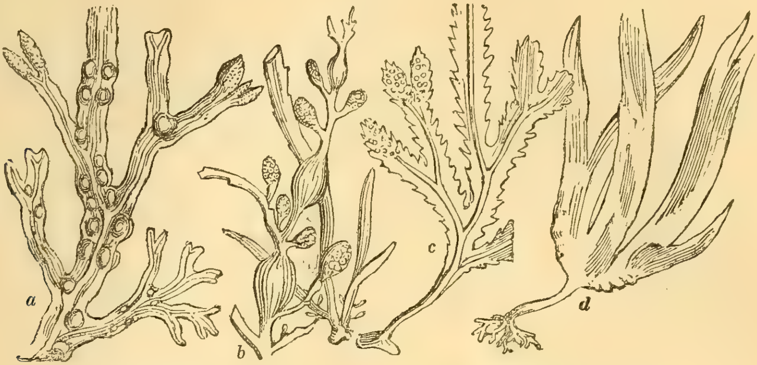
[y] Gmelin, *Handbuch der Chemie*, Bd. i. S. 350.

[z] Dulk, *Die Preussische Pharmakopöe*, Bd. i. S. 583. Leipzig, 1829; and *British and Foreign Medical Review* for January, 1838, p. 163.

[a] *Journ. de Pharmacie*, tom. xxiii. p. 501.

F. *serratus*, and F. *nodosus*; (fig. 47, *a*, *b*, *c*.) *Laminaria saccharina*, and *L. digitata* (fig. 47, *d*); *Halidrys siliquosa*; *Chorda Filum*; *Gelidium cartilageneum*; *Halyseris polypodioides*; *Phyllophora rubens*; *Rhodomenia palmata*; *Ulva Linza*; *Porphyra umbilicalis*; *Padina Pavonia*; *Gigartina Helminthocorton*, and some of the marine *Confervæ*.

FIG. 47.



a. Fucus vesiculosus.
b. F. nodosus.
c. F. serratus.
d. Laminaria digitata.

"The following table, drawn up by Mr. Whitelaw, a manufacturer in Glasgow, from his own experiments, shows the proportion of iodine contained in some of the most common Algæ on our sea coasts:—

	Ratios of Iodine.		*Ratios of Iodine.*
Laminaria digitata	100	Fucus serratus	20
Laminaria bulbosa	65	Fucus bulbosus	15
Laminaria saccharina	35		

"The quantities of chloride of potassium in those Algæ follow nearly the same ratio[b]." Professor Graham states that, according to Mr. Whitelaw, the long elastic stems of the *Rhodomenia palmata* afford most of the iodine contained in kelp.

It has been found in several species of phænogamous plants, as *Zostera marina*, and, more recently, in two growing in Mexico; namely, a species of *Agave*, and one of *Salzola*[c].

PREPARATION.—British Iodine is exclusively manufactured at Glasgow, from the Kelp of the west coast of Ireland and the western islands of Scotland.

The kelp is broken into pieces and lixiviated in water, to which it yields about half its weight of salts. The solution is concentrated by evaporation, and thereby deposits soda salts (common salt, carbonate and sulphate of soda), and on cooling also lets fall crystals of chloride of potassium. The mother liquor (called *iodine ley*) is dense, dark-coloured, and contains the iodine, in the form, it is believed, of iodide of sodium. Sulphuric acid is added, to render the liquor sour, by which carbonic acid, sulphuretted hydrogen, and sulphurous acid gases are evolved, and sulphur is deposited. The workmen set fire to the sulphuretted hydrogen as it escapes, to obviate its bad effects. The acid ley is then introduced into a leaden still (fig. 48, *a*), and heated to 140° F., when binoxide of manganese is added. A leaden head, having two stoppers (*b* & *c*), is then adapted and luted with pipeclay, and to the neck of the head is fitted a series of spherical glass condensers (*d*), each having two mouths opposite to each other, and inserted the one into the other. Iodine is evolved, and is collected in the condensers. The process is watched by occasionally removing the stopper *c*, and additions of sulphuric acid or manganese are made by *b*, if deemed necessary[d].

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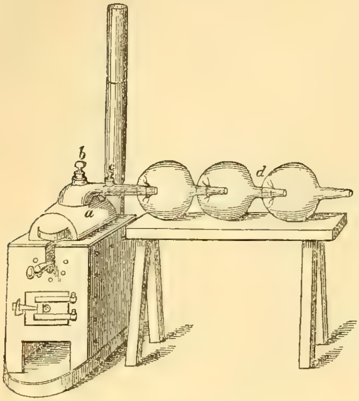
[b] Thomson, *Organic Chemistry*, p. 946.
[c] *Journal de Pharmacie*, t. xxiii. p. 31.

FIG. 48.



Iodine leaden still and glass receivers.

THEORY OF THE PROCESS —The following is the mutual reaction of sulphuric acid, binoxide of manganese, and iodide of sodium:—two equivalents or 80 parts of sulphuric acid, react on one equivalent or 44 parts of binoxide of manganese, and on one equivalent or 150 parts of iodide of sodium; and yield one equivalent or 126 parts of iodine, one equivalent or 72 parts of sulphate of soda, and one equivalent or 76 parts of the sulphate of the protoxide of manganese.

MATERIALS.		COMPOSITION.			PRODUCTS.	
1 eq. Iodide of Sodium	150	*1 eq. Iodine*	126		1 eq. Iodine	126
		1 eq. Sodium	24	*1 eq. Soda* 32		
1 eq. Binoxide Mangan.	44	*1 eq. Oxygen*	8			
		1 eq. Protox. Mang.	36			
2 eq. Sulphuric Acid	80	*1 eq. Sulphuric Acid*	40		1 eq. Sulphate Soda	72
		1 eq. Sulphuric Acid	40		1 eq. Protosulph^{te}Mang.	76
	274		274			274

The evolution of iodine in the preceding process may be also accounted for in another way. By the mutual reaction of sulphuric acid, binoxide of manganese and a chloride (as of sodium or potassium), there is set free chlorine. This reacting on iodide of sodium, would liberate iodine, and form chloride of sodium. Or, the hydriodic acid set free from a solution of iodide of sodium by sulphuric acid, may be decomposed by the nascent chlorine.

PROPERTIES.—Iodine is a crystallizable solid, its primary form being a rhombic octohedron[e]. It is usually met with in micaceous, soft, friable scales, having a greyish black colour, a metallic lustre, an acrid hot taste, and a disagreeable odour somewhat similar to that of chlorine. It fuses at about 225° F., and at 347° is volatilized, though the vapour rises along with that of water at 212°. Iodine vapour is of a beautiful violet colour, and a great specific gravity; namely, 8·716, according to Dumas. Iodine requires 7000 times its weight of water to dissolve it, but alcohol and ether are much better solvents for it. Its atomic weight is about 126 [126·57, Berzelius; 126·3, Turner]; its atomic volume is 1.

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[d] For further details, consult Graham's *Elements of Chemistry*, vol. i. p. 384.—See also Dr. Thomson, in the *Athenæum*, for 1840, p. 772.

[e] Buchner's *Repertorium für die Pharmacie*, 2^{te} Reiter, Band. xx. S. 43. Nürnberg, 1851.

1 eq.
Iodine
Vapour
= 126

Characteristics.—In the free state iodine is distinguished from most other bodies by the violet colour of its vapour, and by its forming a blue compound (iodide of starch) with starch. So delicate is this test, that, according to Stromeyer, water which does not contain more than one four-hundred-and-fifty thousandth of its weight of iodine, acquires a perceptibly blue tinge on the addition of starch. This blue colour is destroyed by heat, and, therefore, in testing for iodine the liquids employed should be cold: an excess of alkali also destroys it by forming two salts, an iodate and an iodide, but by supersaturating with acid the colour is restored.

Iodine as well as the mineral acids (sulphuric, nitric, and hydrochloric) produce a blue colour with narceine (see *Opium*).

When iodine is in combination with oxygen, starch will not recognise it. For example, if a little starch be added to a solution of *iodic acid*, no change of colour is observed; but if some deoxidating substance be now employed (such as sulphurous acid or morphia) the blue colour is immediately produced. The *iodates* give out oxygen when heated, and are converted into iodides. They deflagrate when thrown on red-hot coals. The soluble iodates produce, with a solution of the nitrate of silver, a white precipitate (*iodate of silver*) soluble in ammonia. If the iodine be combined with a base (as with potassium, or sodium) forming an *iodide*, chlorine or sulphuric or nitric acid must be employed to unite with the base; and the iodine being then set free, will react on the starch. This is the mode of proceeding to detect iodine in the urine of a patient; for the mere addition of starch will not suffice. Nitric or sulphuric acid or chlorine must be employed to remove the base with which the iodine is combined. Excess of chlorine will unite with the disengaged iodine.

The soluble iodides produce, with a solution of nitrate of silver, a yellowish precipitate (*iodide of silver*) very slightly soluble only in ammonia. They precipitate the salts of lead yellow (*iodide of lead*), and bichloride of mercury scarlet (*biniodide of mercury*).

ADULTERATION.—The iodine of commerce is always adulterated with variable proportions of *water*. An ounce, if very moist, may contain a drachm, or perhaps even a drachm and a half, of water. This fraud is detected by compressing the iodine between folds of blotting-paper. In this moist state it is "unfit for making pharmaceutic preparations of fixed and uniform strength," and the Edinburgh College gives the following directions for purifying it:—

> "It must be dried by being placed in a shallow basin of earthenware in a small confined space of air, with ten or twelve times its weight of fresh-burnt lime, till it scarcely adheres to the inside of a dry bottle."

Various other substances, such as *coal, plumbago, binoxide of manganese, sand*, and *charcoal*, are also said to have been employed for the purpose of adulterating iodine; but in no samples of iodine which I have examined, have I ever found any of these substances. Pure iodine is completely soluble in alcohol, and evaporates, when heated, without leaving any residuum. Any matter insoluble in alcohol, or even vaporizable by heat, is an adulteration. The Edinburgh College gives the following criteria of its goodness:—

> "Entirely vaporizable: thirty-nine grains, with nine grains of quicklime and three ounces of water, when heated short of ebullition, slowly form a perfect solution, which is yellowish or brownish, if the iodine be pure, but colourless if there be above two per cent. of water or other impurity."

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Cantu states that seeds placed in pure sand and moistened with a solution of iodine, germinate more readily than seeds sown in the usual way. Vogel, however, asserts that iodine, so far from promoting, actually checks or stops germination[ee].

β. *On Animals generally.*—On horses, dogs, and rabbits, it operates as an irritant and caustic poison, though not of a very energetic kind. Magendie threw a drachm of the tincture of iodine into the veins of a dog without causing any obvious effects[f]. Dr. Cogswell has repeated this experiment: the animal was slightly affected only[g]. The last mentioned writer found that two drachms of the tincture caused death. But something must be ascribed to the alcohol employed. Orfila[h] applied 72 grains of solid iodine to a wound on the back of a dog: local inflammation, but no other inconvenience, resulted. One or two drachms administered by the stomach caused vomiting, and when this was prevented by tying the œsophagus, ulceration of the alimentary canal and death took place. Mr. Dick[i] gave iodine, in very large doses, to a horse for three weeks, but the only symptom which could be referred to its influence was an unusual disregard for water. The average daily allowance was two drachms, administered in quantities ascending from a drachm up to two ounces. Dr. Cogswell[j] gave 73 grains of iodine to a dog in nine days. Five days after the cessation of the iodine the dog was killed: the urine contained a highly appreciable quantity of iodine—and a trace, and but a trace, of iodine was found in the blood, brain, and stomach.

γ. *On Man.*—The *local* action of iodine is that of an irritant. Applied to the skin it stains the cuticle orange-yellow, causes itching, redness, and desquamation. If the vapour of it, mixed with air, be inhaled, it excites cough and heat in the air-passages. On a secreting surface its alcoholic solution acts as a desiccant. Swallowed in large doses it irritates the stomach, as will be presently mentioned.

The effects produced by the internal administration of iodine are those of a liquefacient and resolvent[k]. They may be considered under the two heads, of those arising from the use of small,—and those produced by large doses.

[ee] De Candolle, *Physiologie Végétale*, tom. 3me, p. 1337.

[f] *Formulaire.*

[g] *Experimental Essay on Iodine*, p. 31, 1837.

[h] *Toxicologie générale.*

[i] Cogswell's *Essay*, p. 24.

[j] *Op. cit.* p. 60.

[k] See p. 194.

aa. In small, medicinal doses, we sometimes obtain the palliation, or even the removal of disease, without any perceptible alteration in the functions of the body. Thus, in a case of chronic mammary tumour which fell under my observation, iodine was taken daily for twelve months, without giving rise to any perceptible functional change, except that the patient was unusually thin during this period. Sometimes it increases the appetite, an effect noticed both by Coindet[l] and by Lugol[m], from which circumstance it has been denominated a *tonic.* But the long-continued use of it, in large doses, has, occasionally, brought on a slow or chronic kind of gastro-enteritis; an effect which I believe to be rare, and only met with when the remedy has been incautiously administered.

In irritable subjects, and those disposed to dyspepsia, it occasions nausea, sickness, heat of stomach, and loss of appetite, especially after its use has been continued for some days: the bowels are oftentimes slightly relaxed, or at least they are not usually constipated. More than one-third of the patients treated by Lugol experienced a purgative effect; and when the dejections were numerous, colics were pretty frequent[n]. Gendrin[o] and Manson[p], however, observed a constipating effect from the use of iodine.

The action of iodine on the *organs of secretion* is, for the most part, that of a stimulant; that is, the quantity of fluid secreted is usually increased, though this effect is not constantly observed. Jörg[q] and his friends, found, in their experiments on themselves, that small doses of iodine increased the secretion of nasal mucus, of saliva, and of urine, and they inferred that the similar effect was produced on the gastric, pancreatic, and biliary secretions. "Iodine," says Lugol[r], "is a powerful *diuretic.* All the patients using it have informed me that they pass urine copiously." Coindet, however, expressly says that it does not increase the quantity of urine. In some cases, in which I carefully watched its results, I did not find any diuretic effect. Iodine frequently acts as an *emmenagogue.* Coindet, Sablairoles[s], Brera[t], Magendie[u], and many others, agree on this point; but Dr. Manson[v] does not believe that it possesses any emmenagogue powers, further than as a stimulant and tonic to the whole body. In one patient it occasioned so much sickness and disorder of stomach, that the menstrual discharge was suppressed altogether. On several occasions iodine has caused *salivation* and soreness of mouth. In the cases noticed by Lugol, the patients were males. In the *Medical Gazette,* vol. xvii. for 1836, two instances are mentioned, one by Mr. Winslow (p. 401), the other by Dr. Ely (p. 480). Other cases are referred to in Dr. Cogswell's work. This effect, however, I believe to be rare. De Carro (quoted by Bayle [w]) denies that iodine causes salivation, but says it augments *expectoration*. Lastly, *diaphoresis* is sometimes promoted by iodine.

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[l] *Biblioth. Univers.* tom. xiv. Sciences et Arts.
[m] *Essays,* translated by Dr. O'Shaughnessy.
[n] *Op. cit.* p. 20.
[o] *Dict. de Mat. Méd.* t. 3^{me}, p. 628.
[p] *Medical Researches on Iodine.*
[q] *Material zu einer Arzneimittell.* Leipsic, 1824.
[r] *Essays,* p. 19.
[s] *Journ. générale de Méd.* tom. 97.
[t] Quoted by Bayle in his *Bibliothèque de Thérapeutique,* tom. i. p 129.
[u] *Formulaire.*
[v] *Medical Researches on the Effects of Iodine.* London, 1825.

Two most remarkable effects which have been produced by iodine are, *absorption of the mammæ* and *wasting of the testicles*. Of the first of these (absorption of the mammæ), three cases are reported in *Hufeland's Journal* [x], one of which may be here mentioned. A healthy girl, twenty years of age, took the tincture of iodine during a period of six months, for a bronchocele, of which she became cured; but the breasts were observed to diminish in size, and notwithstanding she ceased to take the remedy, the wasting continued, so that at the end of two years not a vestige of the mammæ remained. Sometimes the breasts waste, though the bronchocele is undiminished: Reichenau [y] relates the case of a female, aged twenty-six, whose breasts began to sink after she had employed iodine for four months, and within four weeks they almost wholly disappeared; yet her goïtre remained unaffected. With regard to the other effect (wasting of the testicle) I suspect it to be very rare. I have seen iodine administered in some hundreds of cases, and never met with one in which atrophy either of the breast or testicle occurred. Magendie also never saw these effects, though they are frequent in Switzerland.

A disordered condition of the cerebro-spinal system has in several instances been caused by iodine. Thus, slight headache and giddiness are not unfrequently brought on. Lugol tells us that, by the use of ioduretted baths, headache, drowsiness, intoxication, and even stupor, are produced. Analogous symptoms were observed in some of Dr. Manson's cases; and in one there were convulsive movements.

A specific effect on the skin is sometimes produced by iodine, besides the diaphoresis before alluded to. Thus Dr. C. Vogel [z] gives an account of a lady, twenty-eight years of age, of a yellow complexion, who, from the internal employment of the tincture of iodine, became suddenly brown, besides suffering with other morbid symptoms. After some days the skin had the appearance of having been smoked! Mr. Stedman [a] says that in some scrofulous patients it improves the condition of the hair and scalp. Red hair is said to have assumed a chesnut-brown colour under the long-continued internal use of iodine [b].

The rapid emaciation said to have been occasionally produced by iodine, as well as the beneficial influence of this substance in scrofulous diseases, and the disappearance of visceral and glandular enlargements under its use, have given rise to an opinion that iodine *stimulates the lymphatic vessels and glands* [c]. Manson, however, thinks that it exerts no peculiar or specific influence over the absorbent system, which only participates in the general effects produced on the whole body. And Lugol asserts, that instead of producing emaciation, it encourages growth and increase of size.

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[w] *Op. cit.* p. 50.
[x] Bayle, *op. cit.* p. 162.
[y] Christison, p. 180.
[z] Rust, *Magazin*, Bd. 14, p. 156.
[a] *London Medical Gazette*, vol. xv. p. 447.
[b] Clauzel, *Revue Médicale*, Nov. 1834, p. 30.
[c] See p. 196.

There can be no doubt that the continued use of iodine must have some effect over the general nutrition of the body, and by modifying the actions previously performed by the various organs and systems, it may at one time cause the *embonpoint* described by Lugol, and at another may have the reverse effect: in one case it may promote the activity of the absorbents, and occasion the removal of tumours of considerable size, in another check ulceration (a process which Mr. Key, in the 19th vol. of the *Medico-Chirurgical Transactions*, denies to be one of absorption, but considers to be one of degeneration or disorganization) and cause the healing of ulcers.

Some have ascribed to iodine an *aphrodisiac* operation. Kolley [d], a physician at Breslau, who took it for a bronchocele, says it had the reverse effect on him.

In some instances, the continued use of iodine has given rise to a disordered state of system, which has been designated *iodism.* The symptoms (termed by Dr. Coindet, *iodic*) are violent vomiting and purging, with fever; great thirst; palpitation; rapid and extreme emaciation; cramps, and small and frequent pulse, occasionally with dry cough; and terminating in death. This condition, however, must be a very rare occurrence; for it is now hardly ever met with, notwithstanding the frequency and the freedom with which iodine is employed. But it has been noticed by Coindet [e], Gardner [f], Zink [g], Jahn [h], and others. The daily experience of almost every practitioner proves, that the dangers resulting from the use of iodine have been much exaggerated, and we can hardly help suspecting that many symptoms, which have been ascribed to the injurious operation of this remedy, ought to have been referred to other causes; occasionally, perhaps, they depended on gastro-enteritis. In some cases, the remarkable activity of iodine may have arisen from some idiosyncrasy on the part of the patient. Dr. Coindet attributes the iodic symptoms to the *saturation* of the system with iodine—an explanation, to a certain extent, borne out by the results of an experiment made by Dr. Cogswell, and which I have before mentioned: I allude, now, to the detection of iodine in the tissues of an animal five days after he had ceased taking this substance.

ββ. In very large doses iodine has acted as an irritant poison. In a fatal instance, recorded by Zink [i], the symptoms were restlessness, burning heat, palpitations, very frequent pulse, violent priapism, copious diarrhœa, excessive thirst, trembling, emaciation, and occasional syncope. The patient died after six weeks' illness. On another occasion, this physician had the opportunity of examining the body after death. In some parts the bowels were highly inflamed; in others they exhibited an approach to sphacelation. The liver was very large, and of a pale rose colour.

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[d] *Journ. Complém.* tom. xvii. p. 307.
[e] *Op. cit.*
[f] *Essay on the Use of Iodine.*
[g] *Journ. Complém.* tom. xviii. p. 126.
[h] Quoted by Christison, p. 181.
[i] *Journ. Complém.* tom. xviii.

Such cases, however, are very rare. In many instances, which might be referred to, enormous quantities of iodine have been taken with very slight effects only, or perhaps with no marks of gastric irritation. Thus, Dr. Kennedy[j], of Glasgow, exhibited within eighty days, 953 grains of iodine in the form of tincture: the daily dose was at first two grains, but ultimately amounted to eighteen grains. The health of the girl appeared to be unaffected by it. It should here be mentioned, that the presence of bread, potatoes, sago, arrow-root, tapioca, or other amylaceous matters, in the stomach, will much diminish the local action of iodine, by forming an iodide of starch, which, as will hereafter be mentioned, is a very mild preparation[k].

Modus Operandi.—That iodine becomes absorbed, when employed either externally or internally, we have indisputable evidence, by its detection, not only in the blood, but in the secretions. Cantu[l] has discovered it in the urine, sweat, saliva, milk, and blood. In all cases it is found in the state of iodide, or hydriodate; from which circumstance he concludes that its influence on the body is chemical, and consists in the abstraction of hydrogen. Bennerscheidt[m] examined the serum of the blood of a patient who had employed for some time iodine ointment; but he could not detect any trace of iodine in it. In the crassamentum, however, he obtained evidence of its existence, by the blue tint communicated to starch. It may be readily detected in the urine of patients who have been using iodine, by adding a cold solution of starch and a few drops of nitric acid, when the blue iodide of starch is produced.

Uses.—As a remedial agent iodine is principally valuable for its resolvent influence in chronic visceral and glandular enlargements, indurations, thickening of membranes (as of the periosteum), and in tumours. In comparing its therapeutical power with that of mercury, we observe in the first place that it is not adapted for febrile and acute inflammatory complaints, in several of which mercury proves a most valuable agent. Indeed the existence of inflammatory fever is a contraindication for the employment of iodine. Secondly, iodine is especially adapted for scrofulous,—mercury for syphilitic, maladies; and it is well known that in the former class of diseases mercurials are for the most part injurious. Thirdly, the influence of iodine over the secreting organs is much less constant and powerful than that of mercury;—so that in retention or suppression of the secretions, mercury is for the most part greatly superior to iodine. Fourthly, iodine evinces a specific influence over the diseases of certain organs (*e. g.* the thyroid body), which mercury does not.—These are some only of the peculiarities which distinguish the therapeutical action of iodine from that of mercury.

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[j] Dr. Cogswell's *Essay*.

[k] See the experiments of Dr. Buchanan, presently to be noticed.

[l] *Journ. de Chimie Méd.*

[m] *Ibid.* tom. iv. p. 383.

a. In *bronchocele.*—Of all the remedies yet proposed for bronchocele, this has been by far the most successful. Indeed, judging only from the numerous cases cured by it, and which have been published, we should almost infer that it was a sovereign remedy. However, of those who have written on the use of iodine in this complaint, some only have published a numerical list of their successful and unsuccessful cases. Bayle[n] has given a summary of those published by Coster, Irmenger, Baup, and Manson, from which it appears, that of 364 cases treated by iodine, 274 were cured. Dr. Copland[o] observes that, of several cases of the disease which have come before him since the introduction of this remedy into practice, "there has not been one which has not either been cured or remarkably relieved by it." I much regret, however, that my own experience does not accord with this statement. I have several times seen iodine, given in conjunction with iodide of potassium, fail in curing bronchocele; and I know others whose experience has been similar. Dr. Bardsley[p] cured only nine, and relieved six, out of thirty cases, with iodide of potassium. To what circumstance, then, ought we to attribute this variable result? Dr. Copland thinks that, where it fails, it has been given "in too large and irritating doses, or in an improper form; and without due attention having been paid to certain morbid and constitutional relations of the disease during the treatment."

But, in two or three of the instances before mentioned, I believe the failure did not arise from any of the circumstances alluded to by Dr. Copland, and I am disposed to refer it to some peculiar condition of the tumour, or of the constitution. When we consider that the terms *bronchocele*, *goître*, and *Derbyshire neck*, are applied to very different conditions of the thyroid gland, and that the causes which produce them are involved in great obscurity, and may, therefore, be, and indeed probably are, as diversified as the conditions they give rise to, we can easily imagine, that while iodine is serviceable in some, it may be useless, or even injurious, in others. Sometimes the bronchocele consists in hypertrophy of the substance of the thyroid gland,—that is, this organ is enlarged, but has a healthy structure. In others, the tumefaction of the gland has taken place suddenly, and may even disappear as suddenly; from which it has been inferred, that the enlargement depends on an accumulation of blood in the vessels, and an effusion of serum into its tissue. Coindet mentions a goître which was developed excessively during the first pregnancy of a young female: twelve hours after her accouchement it had entirely disappeared. The same author also relates the circumstance of a regiment composed of young recruits, who were almost every man attacked with considerable enlargement of the thyroid gland, shortly after their arrival at Geneva, where they all drank water out of the same pump. On their quarters being changed the gland soon regained its natural size in every instance. A third class of bronchoceles consists in an enlargement of the thyroid gland from the development of certain fluid or solid substances in its interior, and which may be contained in cells, or be infiltrated through its substance. These accidental productions may be serous, honey-like, gelatinous, fibrous, cartilaginous, or osseous. Lastly, at times the enlarged gland has acquired a scirrhous condition. Now it is impossible that all these different conditions can be cured with equal facility by iodine ; those having solid deposits are, of course, most difficult to ged rid of.

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[n] *Bibliothèque de Thérapeutique*, tom. 1er, p. 394.
[o] *Dict. of Pract. Med.*
[p] *Hospital Facts and Observations*, p. 121.

Kolley, who was himself cured of a large goître of ten years' standing, says, that for the iodine to be useful, the bronchocele should not be of too long standing, nor painful to the touch; the swelling confined to the thyroid gland, and not of a scirrhous or carcinomatous nature, nor containing any stony or other analogous concretions; and that the general health be not disordered by any febrile or inflammatory symptoms, or any gastric, hepatic, or intestinal irritation. If the swelling be tender to the touch, and have other marks of inflammation, let the usual local antiphlogistic measures precede the employment of iodine. When this agent is employed we may administer it both externally and internally. The most effectual method of employing iodine externally is that called *endermic*, already described; namely to apply an ioduretted ointment (usually containing iodide of potassium) to the cutis vera, the epidermis being previously removed by a blister. But the *epidermic*, or *iatroleptic* method, is more usually followed—that is, the ioduretted ointment is rubbed into the affected part, without the epidermis being previously removed, or the undiluted tincture is repeatedly applied to the part by a camel's-hair pencil, while iodine is at the same time administered internally.

With respect to the internal use of this substance, some think that the success depends on the use of small doses largely diluted ; while others consider that as large a quantity of the remedy should be administered as the stomach and general system can bear.

β. *Scrofula* is another disease for which iodine has been extensively used. Dr. Coindet was, I believe, the first to direct public attention to this remedy in the disease in question. Subsequently, Baup, Gimelle, Kolley, Sablairoles, Benaben, Callaway, and others, published cases illustrative of its beneficial effects[q]. Dr. Manson[r] deserves the credit of having first tried it on an extensive scale. He treated upwards of eighty cases of scrofula and scrofulous ophthalmia by the internal exhibition of iodine, sometimes combined with its external employment; and in a large proportion of cases, where the use of the medicine was persevered in, the disease was either cured or ameliorated, the general health being also improved. Three memoirs on the effects of iodine in scrofula have been subsequently published by Lugol, physician to the Hospital St.-Louis, serving to confirm the opinions already entertained of its efficacy. From the first memoir it appears, that in seventeen months—namely, from August 1827, to December 1828—109 scrofulous patients were treated by iodine only; and that of these 36 were completely cured, and 30 relieved; in 4 cases the treatment was ineffectual, and 39 cases were under treatment at the time of the report made by Serres, Magendie, and Dumeril, to the Académie Royale des Sciences. In his illustrative cases we find glandular swellings, scrofulous ophthalmia, abscesses, ulcers, and diseases of the bones, were beneficially treated by it. Lugol employs iodine internally and externally: for internal administration, he prefers iodine dissolved in water by means of iodide of potassium, given either in the form of *drops*, or largely diluted, under the form of what he calls *ioduretted mineral water*, hereafter to be described. His external treatment is of two kinds; one for the purpose of obtaining local effects only, the other for procuring constitutional or general effects. His local external treatment consists in employing ointments or solutions of iodine: the *ointments* are made either with iodine and iodide of potassium, or with the protiodide of mercury; the *solutions* are of iodine and iodide of potassium in water; and according to their strength are denominated caustic, rubefacient, or stimulant: the rubefacient solution is employed in making cataplasms and local baths. His external general treatment consists in the employment of *ioduretted baths*. In the treatment of cutaneous scrofula I have seen the most beneficial results from the application of the tincture of iodine by means of a camel's-hair pencil. It dries up the discharge and promotes cicatrization.

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[q] See Bayle's *Bibliothèque de Thérap.* tom. i.

[r] *Op. cit.*

The successful results obtained by Lugol in the treatment of this disease cannot, I think, in many instances, be referred to iodine solely. Many of the patients were kept several months (some as much as a year) under treatment in the hospital, where every attention was paid to the improvement of their general health by warm clothing, good diet, the use of vapour and sulphureous baths, &c.; means which of themselves are sufficient to ameliorate, if not cure, many of the scrofulous conditions before alluded to. Whether it be to the absence of these supplementary means of diet and regimen, or to some other cause, I know not, but most practitioners will, I think, admit, that they cannot obtain, by the use of iodine, the same successful results which Lugol is said to have met with, though in a large number of cases this agent has been found a most useful remedy.

γ. Iodine has been eminently successful when employed as a resolvent *in chronic diseases of various organs, especially those accompanied with induration and enlargement.* By some inexplicable influence, it sometimes not only puts a stop to the further progress of disease, but apparently restores the part to its normal state. It is usually given with the view of exciting the action of the absorbents, but its influence is not limited to this set of vessels: it exercises a controlling and modifying influence over the blood-vessels of the affected part, and is in the true sense of the word an *alterative*[s].

In chronic inflammation, induration, and enlargement of the *liver*, after antiphlogistic measures have been adopted, the two most important and probable means of relief are iodine and mercury, which may be used either separately or conjointly. If the disease admit of a cure, these are the agents most likely to effect it. Iodine, indeed, has been supposed to possess some specific power of influencing the liver, not only from its efficacy in alleviating or curing certain diseases of this organ, but also from the effects of an over-dose. In one case, pain and induration of the liver were brought on;—and in another, which terminated fatally, this organ was found to be enlarged, and of a pale rose colour[t].

Several cases of enlarged *spleens* relieved, or cured, by iodine have been published.

In chronic diseases of the *uterus*, accompanied with induration and enlargement, iodine has been most successfully employed. In 1828, a remarkable instance was published by Dr. Thetford[u]. The uterus was of osseous hardness, and of so considerable a size as nearly to fill the whole of the pelvis: yet in six weeks the disease had given way to the use of iodine, and the catamenia were restored. In the *Guy's Hospital Reports*, N° I. 1836, is an account, by Dr. Ashwell, of seven cases of "hard tumours" of the uterus successfully treated by the use of iodine, in conjunction with occasional depletion, and regulated and mild diet. Besides the internal use of iodine, this substance was employed in the form of ointment (composed of iodine gr. xv. iodide potassium ℈ij. spermaceti oint. ℥iss.), of which a portion (about the size of a nutmeg) was introduced into the vagina, and rubbed into the affected cervix for ten or twelve minutes every night. It may be applied by the finger, or by a camel's-hair pencil, or sponge mounted on a slender piece of cane. The average time in which resolution of the induration is accomplished varies, according to Dr. Ashwell, from eight to sixteen weeks. "In hard tumours of the walls or cavity of the uterus, resolution, or disappearance, is scarcely to be expected;" but "hard tumours of the cervix, and indurated puckerings of the edges of the os (conditions which most frequently terminate in ulceration) may be melted down and cured by the iodine[v]."

In *ovarian* tumours iodine has been found serviceable[w]. In the *chronic mammary tumour*, described by Sir A. Cooper, I have seen it give great relief—alleviating pain, and keeping the disease in check. In *indurated enlargements of the parotid, prostate, and lymphatic glands*, several successful cases of its use have been published.

δ. As an *emmenagogue* iodine has been recommended by Coindet, Brera, Sablairoles, Magendie, and others. The last-mentioned writer tells us that on one occasion he gave it to a young lady, whose propriety of conduct he had no reason to doubt, and that she miscarried after using it for three weeks. I have known it given for a bronchocele during pregnancy without having the least obvious influence over the uterus.

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[s] See some remarks on the operation of resolvents at p. 196.

[t] Christison, *Treatise on Poisons*, pp. 180-1.

[u] *Trans. of the King and Queen's College of Phys.* Ireland, vol. v.

[v] *Op. cit.* pp. 152-3.

[w] For some remarks, by Sir B. Brodie, on the use of iodine in morbid growths, see Dr. Seymour's *Illustrations of some of the Principal Diseases of the Ovaria.* Lond. 1830.—Also, *London Medical Gazette*, vol. v. p. 750.

ε. In *gonorrhœa* and *leucorrhœa* it has been employed with success after the inflammatory symptoms have subsided.

ζ. *Inhalation* of *iodine vapour* has been used in phthisis and chronic bronchitis. In the first of these diseases it has been recommended by Berton, Sir James Murray, and Sir Charles Scudamore. I have repeatedly tried it in this as well as in other chronic pulmonary complaints, but never with the least benefit. The apparatus for inhaling it has been already described (see p. 152). The liquid employed is a solution of ioduretted iodide of potassium, to which Sir C. Scudamore adds the tincture of conium [x].

η. *Chronic diseases of the nervous system*, such as paralysis and chorea, have been successfully treated by iodine, by Dr. Manson.

θ. In some forms of *the venereal disease*, iodine has been found a most serviceable remedy. Thus Richond (quoted by Bayle [y]) employed it, after the usual antiphlogistic measures, to remove buboes. De Salle cured chronic venereal affections of the testicles with it. Mr. Mayo [z] has pointed out its efficacy in certain disorders which are the consequences of syphilis, such as emaciation of the frame, with ulcers of the skin; ulcerated throat; and inflammation of the bones or periosteum,—occurring in patients to whom mercury has been given.

ι. *In checking or controlling the ulcerative process*, iodine is, according to Mr. Key [a], one of the most powerful remedies we possess. "The most active phagedenic ulcers, that threaten the destruction of parts, are often found to yield in a surprising manner to the influence of this medicine, and to put on a healthy granulating appearance."

κ. Besides the diseases already mentioned, there are many others in which iodine has been used with considerable advantage: for example—*chronic skin diseases*, as lepra, psoriasis, &c. [b];—*dropsies* [c]; *in old non-united fractures*, to promote the deposition of ossific matter [d]; and *in chronic rheumatism;* but, in the latter disease, iodide of potassium is more frequently employed. *As an antidote in poisoning by strychnia, brucia,* and *veratria,* iodine has been recommended by M. Donné [e], because the compound formed by the union of these alkalis with iodine is less active than the alkalis themselves; *as an injection for the cure of hydrocele,* Velpeau [f] has employed a mixture of the tincture of iodine with water, in the proportion of from one to two drachms of the tincture to an ounce of water: of this mixture from one to four ounces are to be injected and immediately withdrawn; lastly, to *check mercurial salivation* iodine has been successfully used [g].

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[x] *London Medical Gazette,* vol. viii. p. 157.

[y] *Op. cit.*

[z] *London Medical Gazette,* vol. xi. p. 249.

[a] *Medico-Chirurg. Trans.* vol. xix.

[b] Cogswell, *Essay,* p. 81.

[c] *Ibid.*

[d] *London Medical Gazette,* vol. vi. p. 512, 1830.

[e] *Journ. de Chim. Méd.* tom. v. p. 494.

[f] *London Medical Gazette,* vol. xx. p. 90.

λ. As *a topical remedy* iodine is exceedingly valuable in several classes of diseases. Mr. Davies [h], of Hertford, has drawn the attention of the profession to its employment in this way, and pointed out the great benefit attending it. In most cases the tincture is the preparation employed. The part affected is painted with this liquid by means of a camel's-hair pencil. In some few cases only, where the skin is very delicate, will it be necessary to dilute the preparation. When it is required to remove the stain which its use gives rise to, a poultice or gruel should be applied. In *lupus* it proves highly beneficial. My attention was first drawn to its efficacy in this disease by my colleague, Mr. Luke. Under its employment the process of ulceration is generally stopped, and cicatrization takes place. The tincture should be applied not only to the ulcerated portion, but to the parts around. In *eczema* it also is an excellent application. In *cutaneous scrofula* likewise, as I have already remarked. In several other cutaneous diseases, such as *lichen*, *prurigo*, *pityriasis*, *psoriasis*, *impetigo*, *porrigo*, *ecthyma*, and *scabies*, Dr. Kennedy [i] has found its use beneficial. According to the testimony of Mr. Davies and an anonymous writer [j], it is a valuable application to *chilblains*. In the treatment of *diseases of the joints* it is used with great advantage. In *erysipelas*, I have seen it highly beneficial. In *phlegmonous inflammation*, *sloughing of the cellular membrane*, *inflammation of the absorbents*, *gout*, *carbuncle*, *whitlow*, *lacerated*, *contused*, *and punctured wounds*, *and burns and scalds*, it is most highly spoken of by Mr. Davies. Its topical uses are, therefore, nearly as extensive as those of nitrate of silver. Moreover, it is used very much in the same classes of cases, and with the same views.

ADMINISTRATION. — Iodine is rarely administered alone, but generally in conjunction with *iodide of potassium*, to the account of which substance I must refer for formulæ for the combined exhibition of these substances.

In the administration of iodine, care should be taken to avoid gastric irritation. On this account we should avoid giving it on an empty stomach. Exhibited immediately after a meal, its topical action is considerably diminished. This is especially the case when amylaceous substances (as potatoes, bread-pudding, sago, tapioca, and arrow-root) have been taken, as the iodine forms with them an iodide of starch. Iodine has been given in the form of pills, in substance, in doses of about half a grain. But this mode of exhibition is objectionable, and is now never resorted to.

1. **TINCTURA IODINII**, D. *Tinctura Iodinei*, E.—*Tincture of Iodine.* (Iodine ℈ij. Rect. Spirit ℥j. [by weight]. D.—The Edinburgh College orders Iodine ʒj. Rect. Spirit f℥xvj.) Principally valuable as a topical remedy. For this purpose it is applied as a paint by a

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[g] *London Medical Gazette*, vol. xiii. p. 32; and vol. xx. p. 144.

[h] *Selections in Pathology and Surgery.* Lond. 1839.

[i] *London Medical Gazette*, vol. xxvi. [May 8, 1840] p. 260.

[j] Ibid. vol. xxv. [March 20, 1840] p. 943.

camel's-hair pencil. It is also used, mixed with four or six parts of soap liniment, as an embrocation. For internal exhibition it is inferior to the *Tinctura Iodinii composita*, L. hereafter to be mentioned. In the first place, by keeping, part of the iodine is deposited in a crystalline form, so that the strength is apt to vary ; secondly, it undergoes decomposition, especially when exposed to solar light; the iodine abstracts hydrogen from the spirit, and forms hydriodic acid, which, acting on some spirit, forms a little hydriodic ether. These are not the only objections: when added to water, the iodine is deposited in a solid state, and may thus irritate the stomach. The dose of it is ♏v. to fʒss. Each drachm of the Dublin tincture contains five grains of iodine. The best mode of exhibiting it, to cover its flavour, is sherry wine. Where this is inadmissible, sugared water may be employed.

2. **IODIDUM AMYLI**; *Iodide of Starch.*—The following is Dr. Buchanan's[k] formula for preparing this substance:—"Rub 24 grs. of iodine with a little water, and gradually add one ounce of finely-powdered starch : dry by a gentle heat, and preserve the powder in a well-stoppered vessel." In persons not labouring under any dyspeptic ailment or constitutional delicacy of habit, Dr. Buchanan commences with half an ounce for a dose, and increases this to an ounce three times a day,—equivalent to about 72 grains of iodine daily. It frequently caused costiveness, attended with griping pains of the bowels and pale-coloured evacuations. Sometimes, though rarely, it produced purging. The dose is ʒss. gradually and cautiously increased. I have found the colour of this preparation objected to by patients.

3. **UNGUENTUM IODINII**, D.; *Iodine Ointment.* (Iodine, ℈j.; Prepared Hog's Lard, ℥j.)—This ointment has a rich orange-brown colour; but by keeping it becomes pale on the surface, and hence should always be made when wanted. It is employed as a local application to scrofulous tumours, bronchocele, &c. If it prove too irritating, the quantity of lard should be augmented.

ANTIDOTES.—In the event of poisoning by iodine, or its tincture, the first object is to evacuate the poison from the stomach. For this purpose, the vomitings are to be assisted by the copious use of tepid demulcent liquids—especially by those containing amylaceous matter; as starch, wheaten flour, sago, or arrow-root, which should be boiled in water, and exhibited freely. The efficacy of these agents depends on their combining with the iodine, to form iodide of starch, which has very little local action. In their absence, other demulcents, such as milk, eggs beat up with water, or even tepid water merely, may be given to promote vomiting. Magnesia is also recommended. Opiates have been found useful. Of course the gastro-enteritis must be combated by the usual means.

COMPOUNDS OF IODINE WITH OXYGEN AND CHLORINE.

None of these are employed in medicine. *Iodic Acid* ($I + O^5$) is used as a test for Morphia and Sulphurous Acid, both of which substances deoxidize iodic acid, and set iodine free.

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[k] *Lond. Med. Gaz.* vol. xviii. p. 515.

ORDER IV.—BROMINE AND ITS COMBINATIONS WITH OXYGEN, CHLORINE, AND IODINE.

BROMIN'IUM, *L.*—BROMINE.

HISTORY AND ETYMOLOGY.—This substance was discovered by M. Balard, of Montpellier, in 1826. He at first termed it *muride* (from *muria*, brine), in allusion to the substance from whence he procured it; but, at the suggestion of Gay-Lussac, he altered this name to that of *brome*, or *bromine*, (from *βρῶμος, a stench,* or *fetor,*) on account of its unpleasant odour.

NATURAL HISTORY.—It is found in both kingdoms of nature, but never in the free state.

α. IN THE INORGANISED KINGDOM.—Hollander detected it in an ore of zinc, and Cochler recognised it in Silesian cadmium[kk]. It exists in sea water and many mineral waters, in combination with either magnesium or sodium, or sometimes with both. Thus it has been found in the waters of the Mediterranean, the Baltic, the North Sea, the Frith of Forth, the Dead Sea, many of the brine springs of Europe and America (as those of Middlewich, Nantwich, Ashby-de-la-Zouch, and Shirleywich, in England), and in many other mineral springs of Europe and America (as the Pittville spring at Cheltenham, the water of Llandridod and of Bonnington). The saline springs near Kreuznach in Germany are especially rich in it. It has been justly observed by Dr. Daubeny[l], that the detection of bromine in brine-springs is a fact interesting in a geological point of view, as tending to identify the product of the ancient seas, in their most minute particulars, with those of the present ocean.

β. IN THE ORGANISED KINGDOM.—Bromine has been found in the sea-plants of the Mediterranean, and in the mother-waters of Kelp. It has likewise been detected in various marine animals. Thus in the Sea-Sponge (*Spongia officinalis*), in the stony concretion found in this animal, in the ashes of the *Janthina violacea*, one of the gasteropodous mollusca, and in cod's-liver oil.

PREPARATION.—Bromine was formerly prepared by a complicated process, from *bittern* (the mother liquor of sea-water, from which chloride of sodium has been separated by crystallization). It is now procured by a simpler method, from the mother-ley of the salt springs near Kreuznach, in Germany. From thirty pounds of the concentrated ley, Liebig obtained twenty ounces of bromine. Of these springs, that of Karshall contains, according to Dr. G. Osann[m], 6·6025 grs. of bromide of calcium, and 1·3672 grs. of bromide of magnesium, in sixteen ounces of the water. According to the same authority, 100 parts of the mother ley of the Münster-am-Stein spring contains 24·12 parts of bromide of calcium, and 0·48 parts of bromide of magnesium. Sixteen ounces of the mother ley of the Theodorshall spring contain 338·72 grs. of bromide of calcium, and 92·82 grs. of bromide of magnesium.

The process followed at Kreuznach, according to Dr. Mohr[n], is that recommended by Desfosses[o], but modified by Löwig[p]. To about four quarts of the mother ley contained in a retort, are added one ounce of binoxide of manganese, and five or six ounces of commercial hydrochloric acid. On the application of the heat of a sand-bath, water and brome pass over into the receiver. When all the brome has passed over, the vapour is observed to be colourless, and to consist of aqueous vapour and hydrochloric acid.

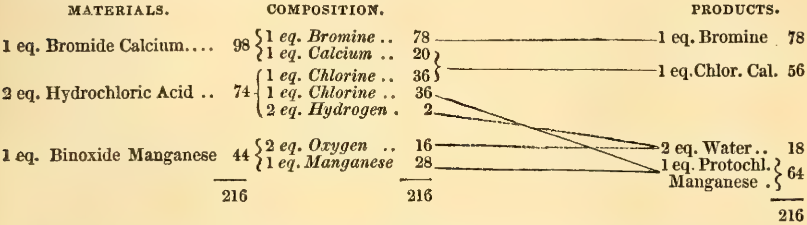
[kk] Gmelin, *Handbuch der Chemie.*

[l] *Phil. Trans.* 1830.

[m] G. W. Schwartze's *Allgemeine und specielle Heilquellenlehre,* Abt. 1, S. 224. Leipzig, 1839.

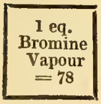
[n] *Annalen der Pharmacie,* Band. xxii. S. 66. Heidelberg, 1837.

The following is the theory of the process :—Two equivalents or 74 parts of hydrochloric acid react on one equivalent or 44 parts of binoxide of manganese, and yield one equivalent or 64 parts of protochloride of manganese, two equivalents or 18 parts of water, and one equivalent or 36 parts of chlorine : the latter, in its nascent state, reacts on one equivalent or 98 parts of bromide of calcium, and produces one equivalent or 56 parts of chloride of calcium, and one equivalent or 78 parts of free bromine.



The mixture of binoxide of manganese and hydrochloric acid is rendered too dilute by the mother ley to produce, by their reaction, free chlorine, when no bromide is present with whose base it can combine. Hence, when all the brome has passed over, we find hydrochloric acid, and not chlorine, in the vapour which is passing over.

PROPERTIES.—At ordinary temperatures bromine is a dark-coloured very volatile liquid, which, seen by reflected light, appears blackish red; but viewed in thin layers, by transmitted light, is hyacinth red. Its odour is strong and unpleasant, its taste acrid. Its sp. gr. is 2·966 ; water being 1. Its equivalent weight is 78 [78·39 Berzelius; 78·4 Turner] ; by volume, in the gaseous form, 1. When exposed to a cold of —4° F. it is a yellowish brown, brittle crystalline solid. At ordinary temperatures liquid bromine evolves ruddy vapours (similar to those of nitrous acid), so that a few drops put into a small vessel immediately fills it with the vapour of bromine. At 116½ F. bromine boils. The vapour is not combustible : a lighted taper plunged into it is immediately extinguished, but before the flame goes out it becomes red at the upper and green at the lower part. Antimony or arsenicum take fire when dropped into liquid bromine : when potassium or phosphorus is dropped in, a violent explosion takes place. Bromine is a nonconductor of electricity : it is a bleaching agent : it dissolves



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[o] *Journal de Chimie Médicale,* t. iii. p. 256. 1827.

[p] *Das Brom und seine chemischen Verhältnisse.* Heidelberg, 1829.

very slightly only in water, more so in alcohol, and much more so in sulphuric ether. It communicates a fine orange colour to starch.

Characteristics.—Liquid bromine is recognised by its colour, odour, volatility, and the colour of its vapour. To these characters must be added its powerful action on antimony, arsenicum, and potassium, before mentioned, its dissolving in ether, forming a hyacinth red liquid, and the orange colour which it communicates to starch. It causes a yellowish white precipitate (*bromide of silver*) with a solution of the nitrate of silver. In its external appearance it resembles the terchloride of chromium and the chloride of iodine. I have known it confounded with tincture of iodine.

The soluble *bromides* cause white precipitates with the nitrate of silver, acetate of lead, and protonitrate of mercury. The precipitates are bromides of the respective metals. Bromide of silver is yellowish white, clotty, insoluble, or nearly so, in boiling nitric acid, and in a weak solution of ammonia (by which it is distinguished from chloride of silver), but dissolves in a concentrated solution of this alkali. Heated with sulphuric acid it evolves vapours of bromine. If a few drops of a solution of chlorine be added to a solution of a bromide, and then a little sulphuric ether, we obtain an ethereal solution of bromine of a hyacinth red colour, which floats on the water.

The *bromates* when heated evolve oxygen, and become bromides. The bromates cause white precipitates (*metallic bromates*) with the nitrate of silver and the protosalts of mercury. Bromate of silver is not soluble in nitric acid, but dissolves readily in solution of ammonia. If a few drops of hydrochloric acid be added to a bromate, and then some ether, a yellow or red ethereal solution of bromine is obtained.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—I am unacquainted with any experiments made with bromine on plants.

β. *On Animals generally.*—The action of bromine on animals has been examined by Franz[q], by Barthez, by Butzke[r], and by Dieffenbach[s]. The animals experimented on were leeches, fishes, birds, horses, rabbits, and dogs. But, notwithstanding the numerous experiments which have been performed, nothing satisfactory has been made out with respect to its mode of operation, beyond the fact of its being a local irritant and caustic, and, therefore, when swallowed, giving rise to gastro-enteritis. Injected into the jugular vein it coagulates the blood, and causes immediate death, preceded by tetanic convulsions. No positive inferences can be drawn as to the specific influence of bromine on any organs of the body. Some of the symptoms (such as dilated pupil, insensibility, and convulsions) would seem to indicate a specific affection of the brain. Franz frequently observed inflammation af the liver.

γ. *On Man.*—Bromine stains the cuticle yellowish brown, and, by continued application, acts as an irritant. Its vapour is very irritating when inhaled, or applied to the mucous lining of the nose, or to the conjunctiva. Franz, by breathing the vapour, had violent cough, and a feeling of suffocation, followed by headache. Butzke swallowed a drop and a half of bromine in half an ounce of water, and experienced heat in the mouth, œsophagus, and stomach, followed by colicy pains. Two drops occasioned nausea, hiccup, and increased secretion of mucus.

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[q] Quoted by Wibmer, *Die Wirkung d. Arzneim.* 1^{er} Bd. S. 433; also in *Journ. Chim. Méd.* t. v. p. 540.

[r] *De Efficacia Bromi interna experimentis illustrata.* Berol. 1829.

[s] Christison, *On Poisons*, p. 167.

The constitutional effects resulting from the continued use of bromine have not been determined. They are probably analogous to those of iodine.

Hitherto no cases of poisoning with it in the human subject have been seen.

USES.—It seems to possess the same therapeutic influence as iodine, and has been administered in bronchocele, in scrofula, in tumors, in amenorrhœa, and against hypertrophy of the ventricles. It is usually regarded as possessing more activity than iodine.

ADMINISTRATION.—It may be administered dissolved in water. An aqueous solution, composed of one part by weight of bromine and forty parts of water, may be given in doses of five or six drops properly diluted and flavoured with syrup. This solution has also been used as an external agent in lotions. (For other formulæ, see *Bromide of Potassium.*)

ANTIDOTES.—The treatment of cases of poisoning by bromine should be the same as for poisoning by iodine. Barthez has recommended magnesia as an antidote.

COMPOUNDS OF BROMINE WITH OXYGEN, CHLORINE, AND IODINE.

None of these have been employed in medicine; nor have they hitherto been applied to any useful purposes in the arts.

ORDER V.—HYDROGEN, AND ITS COMPOUNDS WITH OXYGEN, CHLORINE, AND IODINE.

1. HYDROGEN'IUM.—HYDROGEN.

HISTORY and SYNONYMES.—Cavendish may be considered as the real discoverer of hydrogen, though it must have been occasionally procured, and some of its properties known, previously. He termed it *inflammable air.* Lavoisier called it hydrogen (from ὕδωρ, water, and γεννάω, I beget or produce), because it is the radicle or base of water.

NATURAL HISTORY.—It is found in both kingdoms of nature, but always in combination.

α. IN THE INORGANISED KINGDOM.—Next to oxygen, it may be regarded as the most important constituent of the terraqueous globe. It constitutes 11·1 per cent. by weight of water, presently to be noticed. It is an essential constituent of some minerals (as coal and sal ammoniac), in which it does not exist as an element of water. Lastly, it is evolved from volcanoes, or from fissures in the earth, in combination with carbon, sulphur, chlorine or nitrogen, under the forms of light carburetted hydrogen, sulphuretted hydrogen, hydrochloric acid, and ammonia.

β. IN THE ORGANISED KINGDOM.—Hydrogen is an essential constituent of all organised beings (animals and vegetables), either combined with oxygen, to form water, or otherwise. Certain fungi exhale hydrogen gas both night and day[t].

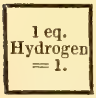
PREPARATION.—Hydrogen is always procured by the decomposition of water, but this may be effected in three ways—by the action of electricity, of heat and iron, or of sulphuric acid and a metal (zinc or iron). The latter method only will require notice here.

Add some granulated zinc to a mixture of 1 part sulphuric acid and 5 or 6 parts of water by measure. One equivalent or 32 parts of zinc decompose one equivalent or 9 parts of water, and unite with one equivalent or 8 parts of oxygen, forming one equivalent or 40 parts of the oxide of zinc, while an equivalent or 1 part of hydrogen is evolved from the water. This equivalent of oxide of zinc combines with an equivalent or 40 parts of sulphuric acid, and forms one equivalent or 80 parts of the sulphate of zinc.

MATERIALS.		COMPOSITION.			PRODUCTS.	
1 eq. Water	9	*1 eq. Hydrogen*	1		1 eq. Hydrogen	1
		1 eq. Oxygen	8	*1 eq. Oxide Zinc* 40		
1 eq. Zinc			32			
1 eq. Sulphuric Acid			40		1 eq. Sulphate Zinc	80
			81			81

It is remarkable that zinc alone does not decompose water, but sulphuric acid enables it to do so.

PROPERTIES.—Hydrogen is a colourless, tasteless, and, when pure, odourless gas. Its sp. gr. is 0·0694,—so that it is 14·4 times lighter than atmospheric air. Its refractive power is very high. It is combustible, burning in atmospheric air or oxygen gas with a pale flame, and forming water. It is not a supporter of combustion. It is a constituent of some powerful acids, as the hydrochloric, and of a strong base, ammonia. Its atomic weight or equivalent is 1. Its atomic volume is also 1.



Characteristics.—It is recognised by its combustibility, the pale colour of its flame, its not supporting combustion, and by its yielding when exploded with half its volume of oxygen, water only.

PHYSIOLOGICAL EFFECTS.—*a. On Vegetables.*—Plants which are deprived of green or foliaceous parts, or which possess them in small quantity only, cannot vegetate in hydrogen gas: thus seeds will not germinate in this gas: but vegetables which are abundantly provided with these parts vegetate for an indefinite time in hydrogen[u]. Applied to the roots of plants in the form of gas, it is injurious[v], but an aqueous solution of it seems to be inert[w]. It has been said that when plants are made to vegetate in the dark, their etoliation is much diminished if hydrogen gas be mixed with the air around them; and in proof of this Humboldt has mentioned several green plants found in the Freyberg mines[x].

β. On Animals generally.—Injected into the jugular vein of a dog hydrogen produces immediate death, probably from its mechanical effects in obstructing the circulation and respiration[y].

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[t] De Candolle, *Phys. Vég.* tom. i. p. 459.
[u] Saussure, *Recherches Chém. sur la Végét.* pp. 195 and 209.
[v] *Ibid.* p. 105.
[w] De Candolle, *Physiol. Végét.* t. iii. p. 1360.
[x] Thomson's *Syst. of Chemistry,* vol. iv. p. 347-8, 6th edit.

γ. *On Man.* — It may be breathed several times without any injurious effects. Scheele made twenty inspirations without inconvenience. Pilatre de Rozier frequently repeated the same experiment, and to shew that his lungs contained very little atmospheric air, he applied his mouth to a tube, blew out the gas, and fired it, so that he appeared to breathe flame. If much atmospheric air had been present detonation must have taken place in his lungs[z]. If we speak while the chest is filled with hydrogen, a remarkable alteration is perceived in the tone of the voice, which becomes softer, shriller, and even squeaking. That this effect is, in part at least, if not wholly, physical, is shewn by the fact that wind instruments (as the flute, pitchpipe, and organ) have their tones altered when played with this gas. The conclusion which has been drawn by several experimenters as to the effects of breathing hydrogen is, that this gas possesses no positively injurious properties, but acts merely by excluding oxygen.

Uses.—*a.* In *pulmonary consumption* Dr. Beddoes recommended inhalations of a mixture of atmospheric air and hydrogen gas, on the ground that in this disease the system was hyperoxygenised. The inhalation was continued for about fifteen minutes, and repeated several times in the day[a]. Ingenhousz fancied that it had a soothing effect when applied to wounds and ulcers.

β. In *rheumatism and paralysis* it has been used by Reuss as a resolvent.

γ. A *flame of hydrogen* has been employed in Italy as a cautery, to stop caries of the teeth[b].

δ. *Hydrogen water* (an aqueous solution, prepared by artificial pressure) has been employed in diabetes[c].

2. A'QUA.—WATER.

(Protoxide of Hydrogen.)

History.—The ancients regarded water as an elementary substance, and as a constituent of most other bodies. This opinion, apparently supported by numerous facts, was held until the middle of the last century, when the Hon. Mr. Cavendish proved that this liquid was a compound of oxygen and hydrogen. It is, however, only doing justice to Mr. Watt, to say, that he had previously inferred this to be the composition of water, but was deterred from publishing his opinion in consequence of some of Dr. Priestley's experiments being, apparently, opposed to it[d].

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[y] Nysten, *Recherches*, p. 10.

[z] Beddoes, *New Method of treating Pulmonary Consumption*, p. 44.

[a] *Op. supra cit.*

[b] *Dict. Mat. Méd.* par Mérat et De Lens.

[c] *Ibid.*

[d] For further details respecting the history of the discovery of the composition of water, see Lord Brougham's memoir on this subject, in Jameson's *Edinburgh New Philosophical Journal*, vol. xxvii.

NATURAL HISTORY.—Water is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—Water exists in the atmosphere; it forms seas, lakes, and rivers; it is mechanically disseminated among rocks; and, lastly, it constitutes an essential part of some minerals.—In the atmosphere it is found in two states: as a vapour (which makes about one-seventieth by volume, or one one-hundredth by weight, of the atmosphere) it is supposed to be the cause of the blue colour to the sky; and, in a vesicular form, it constitutes the clouds. Terrestrial water forms about three-fourths of the surface of the terraqueous globe. The average depth of the ocean is calculated at between two or three miles. Now, as the height of dry land above the surface of the sea is less than two miles, it is evident, that if the present dry land were distributed over the bottom of the ocean, the surface of the globe would present a mass of waters a mile in depth. Even on the supposition that the mean depth of the sea is not greater than the fourth part of a mile, the solid contents of the ocean would be 32,058,939¾ cubic miles[e]. The quantity of water disseminated through rocks must be, in the aggregate, very considerable, although it is impossible to form any correct estimate of it. Water enters into the composition of many minerals, either as *water of crystallization*, or combined as a *hydrate*.

β. IN THE ORGANISED KINGDOM it is an essential constituent of vegetables and animals.

PROPERTIES.—Pure water has the following properties:—at ordinary temperatures it is a transparent liquid, usually described as being both odourless and colourless; but it is well known that the camel can scent water at a considerable distance; so that to this animal it is odorous;—and as regards its colour, we know that all large masses of water have a bluish-green colour[f], though this is usually ascribed to the presence of foreign matters. When submitted to a compressing force equal to 30,000 lbs. on the square inch, 14 volumes of this liquid are condensed into 13 volumes; so that it is elastic. A cubic inch of water, at 60° F., weighs 255·5 grains; so that this fluid is about 815 times heavier than atmospheric air: but being the standard to which the gravities of solids and liquids are referred, its specific weight is usually said to be 1·. "A pint weighs, at 62°, 8,750 grs., or 20 ozs. avoirdupois; or 1 lb. 6 ozs. 1 drachm 2½ scruples, or 10 grs. less than 18¼ ozs. apothecaries' weight[g]." At a temperature of 32° it crystallizes, and in so doing expands. The fundamental form of crystallized water (ice) is the rhombohedron. Water evaporates at all temperatures, but at 212° boils, and is converted into steam, whose bulk is about 1700 times that of water, and whose sp. gr. is 0·6249 (that of hydrogen being 1). Water unites with both acids and bases, but without destroying their acid or basic properties. Thus the crystallized vegetable acids, tartaric, citric, and oxalic, are atomic combinations of water with what are termed dry acids. Potassa fusa and slacked lime may be instanced as compounds of water and basic substances: these are called *hydrates*. It is a chemical constituent of some crystallized salts; for example, alum, sulphate of soda, and sulphate of magnesia. Here it exists as *water of crystallization*. It rapidly absorbs some gases,—as fluoride of boron, ammonia, &c. It is neither combustible nor a supporter of combustion.

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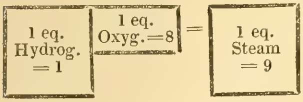
[e] Thomson's *System of Chemistry*, 6th ed. vol. iii. p. 195.

[f] For some remarks on the colour of the ocean, see Jameson's *Journal*, vol. xxv.

[g] Mr. Phillips's *Translation of the Pharmacopœia*, 4th ed. 1841.

Characteristics.—In the liquid state it is recognized by being volatile, tasteless, odourless, neither acid nor alkaline, and not combustible nor a supporter of combustion: it is miscible with alcohol, but not with the fixed oils: if potassium be thrown on it in the open air, the metal takes fire. Lastly, water may be decomposed into oxygen and hydrogen by the galvanic agency. The most delicate test of aqueous vapour in any gas, is fluoride of boron (commonly called fluoboric acid gas), which produces white fumes with it.

Composition.—The composition of water is determined both by analysis and synthesis. If this liquid be submitted to the influence of a galvanic battery, it is decomposed into two gases; namely, one volume of oxygen, and two volumes of hydrogen. These gases, in the proportions just mentioned, may be made to recombine, and form water, by heat, electricity, or spongy platinum.



	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berz. & Dulong.*
Hydrogen	1	1	11·11	11·1
Oxygen	1	8	88·88	88·9
Water	1	9	100·00	100·0

	Vol.	*Sp. Gr.*
Hydrogen gas	1	0·0694
Oxygen gas	0·5	0·5555
Aqueous vapour	1	0·6249

Physiological Effects.—Considered in a dietetical point of view the effects of water on the system have been already considered[h]. Moreover, as an agent for the communication or abstraction of heat to or from the body, it has been before noticed[i]. Furthermore, the influence of atmospheric humidity in modifying the character of climates has likewise been briefly referred to[j].

Water moderately warm, and which neither cools nor heats the body, acts locally as an emollient, softening and relaxing the various tissues to which it is applied. When swallowed it allays thirst, becomes absorbed, mixes with, and thereby attenuates, the blood, and promotes exhalation and secretion, especially of the watery fluids. Administered in large quantities it excites vomiting. The continued excessive use of water has an enfeebling effect on the system, both by the relaxing influence on the alimentary canal and by the excessive secretion which it gives rise to.

Injected into the veins in moderate quantities, tepid water has no injurious effects; it quickens the pulse and respiration, and increases secretion and exhalation. Large quantities check absorption[k], and cause difficulty of breathing and an apoplectic condition. Thrown with force into the carotid artery it kills by its mechanical effect on the brain.

Uses.—Besides the dietetical and thermotic purposes for which water is employed in medicine, and which have been already noticed, it serves as a diluent, humectant, emollient, evacuant, and, in pharmacy, as a solvent.

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[h] See p. 68.
[i] See *Moist Heat*, a. *Aqueous Vapour*, p. 14; b. *Water*, p. 18; *Cold Water*, p. 25.
[j] See p. 82.
[k] See p. 114.

Water or bland aqueous liquids are employed in some cases of poisoning. They serve to dilute the acrid and irritant poisons, the intensity of whose action on the stomach they lower. Moreover, the presence of aqueous fluids favours the expulsion of substances by vomiting.

In preternatual dryness and rigidity of parts (*e. g.* of mucous surfaces, the skin, wounds, and ulcers), water and mild aqueous fluids are useful moisteners and emollients.

The copious use of water augments the quantity of fluid thrown out of the system by the cutaneous and pulmonic surfaces, and by the kidneys. If our object be to promote diaphoresis, external warmth should be conjoined with the internal use of diluents; whereas when we wish to excite the renal vessels the skin should be kept cool. In inflammatory affections of the urinary passages, we advise the free employment of aqueous fluids, with the view of diluting the urine, and thereby of rendering it less acrid and irritating.

In Germany there are thirteen or fourteen establishments, formed within the last few years, for the cure of maladies by the use of water. This method of treatment is denominated *Water-cure* (Wassercur), *Water-medicine* (Wasserheilkunst), or *Methodus Hydriatica.*

The following is a sketch of the regimen usually adopted at these establishments:—

> At four, or half past four in the morning, perspiration is begun to be produced, which is done by wrapping the patients, like babies, in swaddling clothes, or like mummies, in large and thick blankets. Perspiration usually begins in an hour, and is kept up by making the patients drink several glasses of cold water every half hour. In many cases, when the perspiration is at its height, pieces of cloth dipped in cold water, and previously well wrung, are dexterously introduced under the blankets, and applied to the most diseased parts; these parts, as well as the cloths, grow hot, the perspiration soon begins afresh, and causes a sensation of burning in the part.
>
> At the end of three hours the blankets and bed are soaked with perspiration; the patients are then conducted into a neighbouring room, or to another story, where they take their cold baths; and in doing this, they often pass through draughts of air without being inconvenienced. Before plunging into the cold bath, they wash their head and chest; and after staying in it two or three minutes, the patients take a few cups of milk with a little bread, and then walk out upon the mountains which border on the establishment, and drink cold water at the numerous springs which they meet upon their route. About nine or ten o'clock they take the douche, or else walk to the cascades which are in the forests or mountains, and expose themselves to the fall of the water that comes down from a height, and strikes the body with great force. Immediately after dressing, they again drink several glasses of water, and then walk in the open air[l].

This mode of treatment is recommended for old and young, males and females, and is followed both in summer and winter. It is regarded as a kind of universal remedy or panacea. Thus Oertel[m] says it is good for affections of the eyes, ears, and teeth, for insanity, epilepsy, hydrophobia, erysipelas, quinsy, bronchial phthisis, inflammation of the brain, chest, or abdomen, faintings, diseases of the liver and spleen, gout, stomach complaints, acute eruptions, hemorrhages, alvine obstructions, &c. ! ![n]

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[l] *London Medical Gazette,* for Oct. 12, 1839, p. 111.

[m] *Die allerneuesten Wasserkuren,* 18 Hefte. Nürnberg, 1829-37.

What is called *Water-dressing* may be regarded as a modified and improved form of poultice. It consists in the application of two or three layers of soft lint dipped in water and applied to inflamed parts, wounds, and ulcers;—the whole being covered with oiled silk or Indian rubber, which should project beyond the margin of the lint, to retain the moisture and prevent evaporation. Dr. Macartney[o] considers it to operate differently to a poultice: unlike the latter, he says, it prevents or diminishes the secretion of pus, checks the formation of exuberant granulations, and removes all pain. Moreover, the water is not apt to become sour, like a poultice, and does not injure the sound part[p].

Water is frequently employed in pharmacy for extracting the active principles of various medicinal agents. The solutions thus procured are termed by the French reformers[q] of pharmaceutical nomenclature, *hydroliques*, or *hydrolica*, (from ὕδωρ, *water*). Those prepared by solution or mixture are termed *hydrolés*, and are divided by Cottereau[r] into three classes; mineral (as lime water), vegetable (as almond emulsions, mucilage, infusions, decoctions, &c.), and animal (as broths). Those obtained by distillation are denominated *hydrolats*.

1. **AQUA DESTILLATA**, L.E. *Aqua Distillata*, D.—*Distilled Water.*—(Obtained by distilling Common Water in a proper still. The first twentieth [fortieth, *L.*] part should be rejected: the last portions ought not to be distilled). The first distilled portion is to be rejected, as it may contain carbonic acid, and other volatile impurities. The latter portions are not to be distilled, to guard against empyreuma. The still in which the operation is conducted ought not to be employed for any other purpose, otherwise the water is apt to receive a faint smell, and taste of the last matters subjected to distillation. Distilled water remains unchanged on the addition of any of the following tests: — Solutions of the Caustic Alkalis, Lime, Oxalic Acid, the Barytic Salts, Acetate of Lead, Nitrate of Silver, and Soap. If turbidness, milkiness, or precipitate, be occasioned by any of these, we may infer the existence of some impurity in the water. But water which has been repeatedly distilled gives traces of acid and alkali when examined by the agency of voltaic electricity, which, therefore, is the most delicate test of the purity of water. Nitrate of Silver is the most sensible test of the presence of organic

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[n] For further details concerning this mode of treatment, consult, besides the works above quoted, Fabricius, *Das Ganze der Heilkunst mit kaltem Wasser*, 2te Aufl. Leipzig, 1834;—*Die Wasserkur zu Gräfenberg, oder die Kunst, durch Anwendung des kalten Wassers Wärme zu erzeugen*, Lissa, 1837;—Most, *Encyklopädie der gesammten medicinischen und chirurgischen Praxis*, Band. ii. S. 458, art. *Methodus hydriatica*, Leipzig, 1837.

[o] *Treatise on Inflammation*, p. 180. London, 1838.

[p] For further details respecting the water-dressing, see, besides the work already quoted, *Mém. de l'Académie Royale de Médecine*, Fasc. 1, 1836; *Lancet*, vol. ii. for 1834-5, pp. 121, 277, and 484; and vol. i. for 1835-6, p. 450.

[q] *Pharmaceutical Nomenclature* of MM. Chereau and Henry, in Duncan's *Supplement to the Edinburgh New Dispensatory*, p. 152.

[r] *Traité Elémentaire de Pharmacologie.* Paris, 1835.

matter[s]: a solution of this salt in pure water, preserved in a well-stoppered bottle, undergoes no change of colour by exposure to light; but if any vegetable or animal matter be present, the metal is partially reduced, and the liquid acquires a dark or reddish tint.

2. AQUÆ MEDICATÆ; *Medicated Waters; Aquæ Destillatæ*, L.; *Aquæ Distillatæ*, D.; *Distilled Waters*, E.; *Hydrolata*, or *Hydrolats.*—(Obtained by submitting either fresh, salted, or dried vegetables, or their essential oils, to distillation with water; or by diffusing the essential oils through water by means of spirit, sugar, gum, or magnesia.) The medicated waters prepared by distillation from recent vegetables have a finer flavour than those obtained by the diffusion of the oil; but the latter are purer and more permanent. Rose and Elder Waters are prepared either from the fresh or pickled (salted) flowers. The medicated waters in most common use may be extemporaneously prepared

"by carefully triturating a drachm of any distilled Oil with a drachm of Carbonate of Magnesia, and afterwards with four pints of distilled water. Lastly, let the water be strained."—*Ph. Lond.*

The magnesia effects the minute division of the oil. Moreover, when the oils possess acid properties (as the old oils of pimento, cloves, and cinnamon), it probably serves to saturate them. Prepared in this way the medicated waters usually contain a minute portion of magnesia in solution: hence, by exposure to the air, they attract carbonic acid, and let fall flocculi of carbonate of magnesia. Moreover, the magnesia unfits them for the preparation of solutions of some of the metallic salts (*e. g.* bichloride of mercury and nitrate of silver). Sugar is frequently employed, instead of magnesia, to aid the diffusion of the oil through water. Or the oil may be dissolved in rectified spirit, and the solution thus prepared, mixed with water.

3. INFUSA, L. D. *Infusions*, E.—These are aqueous solutions of vegetable substances obtained without the aid of ebullition. They are prepared by digesting soft water (cold or hot, according to circumstances) on the substance sliced, bruised, or reduced to coarse powder, in a glazed earthenware or porcelain vessel, fitted with a cover. Polished metallic vessels retain the heat better, but are objectionable on account of their ready corrosion. Hard water is a less perfect solvent of organic matter than soft water, and, moreover, it becomes turbid (from the deposition of chalk) by keeping: hence it should not be employed in the preparation of infusions. Cold water is used when the active principle is very volatile; or when it is desirable to avoid the solution of any substance soluble in hot water. Thus, when the object is to extract the bitter principle from Calumba or Iceland Moss without taking up the starchy matter, cold water is preferred. In general, however, boiling water is used. Infusions are preferred to decoctions when the active principle is either volatilisable by a boiling heat, as in the case of essential oil; or readily undergoes some chemical change by ebullition, as in the case of senna.

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[s] Dr. Davy, in Jameson's *Edinburgh New Philosophical Journal*, Dec. 1828, p. 129.

4. **DECOCTA**, L. D. *Decoctions*, E.—These are prepared by boiling organic substances in water. They should be strained while hot; since, in some cases (*e. g.* cinchona), the liquid becomes turbid on cooling.

Division.—Natural waters may most conveniently be arranged in three classes[t]; viz. *Common Water*, *Sea Water*, and *Mineral Waters*.

a. Aquæ Communes.—Common Waters.

Under this head are comprehended those waters which are used for dressing food, and for other purposes of domestic economy. It includes the waters commonly known as *rain*, *spring*, *river*, *well or pump*, *lake*, and *marsh waters*.

1. **AQUA PLUVIALIS**; *Aqua Pluvia; Aqua Imbrium; Rain Water.*—This is the purest of all natural waters. Its composition, however, varies somewhat in different situations, owing to the foreign substances floating in the atmosphere, and with which it becomes contaminated. It contains *air*, *carbonic acid*, some traces of *nitric acid*, *salts*, and *organic matter*. The nitric acid is presumed to be formed by the combination of the oxygen and nitrogen of the air by the agency of electricity.

Liebig[u] has shewn that rain water contains carbonate of ammonia, to which he ascribes its softness. Carbonate of lime is another constituent, as is also, according to Bergmann, chloride of calcium. Zimmermann found oxide of iron and chloride of potassium in rain; but Kastner could discover no trace of iron in it, though he found in dew, meteoric iron and nickel. Brandes detected various other inorganic substances, viz. chloride of sodium (in greatest quantity), chloride of magnesium, sulphate and carbonate of magnesia, and sulphate of lime. He likewise mentions oxide of manganese. The putrefaction to which rain-water is subject, shews that some organic matter is present. The term *pyrrhin* (from πυῤῥὸς, red) has been applied by Zimmermann to an atmospheric organic substance which reddens solutions of silver. Whenever rain-water is collected near large towns, it should be boiled and strained before use. As it contains less saline impregnation than other kinds of natural waters, it is more apt to acquire metallic impregnation from leaden cisterns and water pipes[v].

Snow Water (*Aqua ex nive; Aqua nivalis*) is destitute of air and other gaseous matters found in rain; and hence fish cannot live in it. It has long been a popular, but erroneous opinion, that it was injurious to the health, and had a tendency to produce bronchocele. But this malady "occurs at Sumatra, where ice and snow are never seen; while, on the contrary, the disease is quite unknown in Chili and Thibet, although the rivers of these countries are chiefly supplied by the melting of the snow with which the mountains are covered[w]." Snow does not quench thirst; on the contrary, it augments it; and the natives of the Arctic regions "prefer enduring the utmost extremity of this feeling, rather than attempt to remove it by eating of snow[x]." When melted, however, it proves as efficacious as other kinds of water.

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[t] See Dr. Thomson's *System of Chemistry*, vol. iii. p. 191, 6th ed. Lond. 1820.

[u] *Organic Chemistry in its Application to Agriculture and Physiology*; edited by Lyon Playfair, Ph. D. Lond. 1840.

[v] See p. 69.

2. **AQUA FONTANA**; *Aqua*, E.; *Spring Water.*—This is rain water which, having percolated through the earth, reappears at the surface of some declivity. During its passage it almost always takes up some soluble matters, which of course vary according to the nature of the soil. Its constituents are similar to those of well water.

"For pharmaceutic use, spring water must be so far at least free of saline matter as not to possess the quality of hardness, or contain above a 6000th of solid matter."—*Ph. Ed.*

3. **AQUA EX FLUMINE**; *Aqua Fluvialis; River Water.*—This is a mixture of rain and spring water. When deprived of the matters which it frequently holds in suspension, its purity is usually considerable. The following are the solid constituents of the waters of the Thames and Colne, at different localities, according to the analyses of Mr. R. Phillips[y]:—

	THAMES WATER.			COLNE WATER.		
QUANTITY OF WATER. 1 Gallon = 10 lbs. Avoirdupois, at 62° F. or 70000 grs. Avoirdup.	*Brentford* Source of the Grand Junction Water Works Company.	*Barnes.* Source of the West Middlesex Water Works Company.	*Chelsea.* Source of the Chelsea Water Works Company.	*Otterpool.* Spring near Bushey.	*Main Spring* in the valley that supplies the Colne.	*Colne* Itself.
	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Carbonate of Lime	16·000	16·900	16·500	18·800	19·300	18·100
Sulphate of Lime Chloride of Sodium	3·400	1·700	2·900	2·500	2·500	3·200
Oxide of Iron Silica Magnesia Carbonaceous matter	Very minute portions.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.
Solid matter held in solution	19·400	18·600	19·400	21·300	21·800	21·300
Mechanical Impurity	0·368	0·368	0·238	0·185	0·262	0·126
Total Solid matter	19·768	18·968	19·638	21·485	22·062	21·426

No notice is taken in these analyses of the gaseous constituents (air and carbonic acid) of river water.

4. **AQUA EX PUTEO**; *Aqua Puteana; Well Water.*—This is water obtained by sinking wells. As it is commonly raised by means of a pump, it is frequently called *pump water*. The constituents of ordinary well water are similar to those of river water above mentioned; but the earthy salts (especially the sulphate of lime) are found

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[w] Paris, *Pharmacologia*, 6th ed. vol. i. p. 79.

[x] *Narrative of a Second Voyage in Search of a North-west Passage; and of a Residence in the Arctic Regions during the years* 1829, 1830, 1831, 1832, *and* 1833, p. 366. Lond. 1835.

[y] *Report from the Select Committee of the House of Lords, appointed to inquire into the supply of Water to the Metropolis*, p. 91, 1840.—See also Dr. Bostock's analysis in the *Report of the Commissioners appointed to inquire into the state of the supply of Water in the Metropolis*, 1828.

in much larger quantity. It usually decomposes and curdles soap, and is then denominated *hard water*, to distinguish it from river and other waters, which are readily miscible with soap, and which are termed *soft waters*. The hardness of water depends on earthy salts, the most common of which is sulphate of lime. By the mutual action of this salt and soap, double decomposition is effected: the sulphuric acid unites with the alkali of the soap, setting free the fatty acids, which unite with the lime to form an insoluble earthy soap. Hard water is a less perfect solvent of organic matter than soft water; hence, in the preparation of infusions and decoctions, and for many economical purposes, as for tea-making and brewing, it is inferior to soft water; and, for the same reason, it is improper as a drink in dyspeptic affections. Moreover, it proves injurious in urinary deposits. The unfavourable effects of hard waters on the animal system are especially manifested in horses. "Hard water, drawn fresh from the well," observes Mr. Youatt[z], "will assuredly make the coat of a horse, unaccustomed to it, stare, and it will not unfrequently gripe and otherwise injure him. Instinct, or experience, has made even the horse himself conscious of this; for he will never drink hard water if he has access to soft: he will leave the most transparent and pure [?] water of the well for a river, although the water may be turbid, and even for the muddiest pool[a]."

Artesian Wells.—These are vertical, cylindrical borings[b] in the earth, through which water rises, by hydrostatic pressure, either to the surface (*spouting* or *overflowing wells*), or to a height convenient for the operation of a pump[c]. They have been denominated Artesian, from a notion that they were first made in the district of Artois, in France. It is probable, however, that they were known to the ancients, for a notice of them is said to occur in Olympiodorus[d]. Proposals have been made for supplying London with water by these wells; which would derive their water from the stratum of sand and plastic clay, placed between the London clay and the chalk basin[e]. But it does not appear that a sufficient supply can be obtained in this way[f].

5. AQUA EX LACU; *Lake Water*.—This is a collection of rain, spring, and river water, usually contaminated with putrefying organic matter, the ill effects of which on the system I have before alluded to[g].

6. AQUA EX PALUDE; *Marsh Water*.—This is analogous to Lake water, except that it is altogether stagnant, and is more loaded with putrescent matter. The sulphates in sea and other waters are decomposed by putrefying vegetable matter, with the evolution of sulphuretted hydrogen; hence the intolerable stench from marshy and swampy grounds liable to occasional inundations from the sea[h].

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[z] *The Horse*, p. 359. Lond. 1831,

[a] "Some trainers have so much fear of hard or strange water, that they carry with them to the different courses the water that the animal has been accustomed to drink, and that they know agrees with it."

[b] For a description of the mode of boring, and of the tools used, see Ure's *Dictionary of Arts, Manufactures, and Mines*, p. 57. London, 1839.

[c] In the *Penny Cyclopædia*, art. *Artesian Wells*, is a popular and interesting account of these wells.

[d] Passy, *Description Géologique du Département de la Seine Inférieure*, p. 292. Rouen, 1832.

[e] See an interesting account of Artesian Wells, by Mr. Webster, in the *Athenæum* for 1839, p. 131.

[f] Ibid. Also, *Transactions of the Institution of Civil Engineers*, vol. iii. part iii.

[g] See p. 69.

TESTS OF THE USUAL IMPURITIES IN COMMON WATERS.—The following are the tests by which the presence of the ordinary constituents or impurities of common waters may be ascertained:—

1. EBULLITION.—By boiling, Air and Carbonic Acid gas are expelled, while Carbonate of Lime (which has been held in solution by the carbonic acid) is deposited. The latter constitutes the fur or crust which lines tea-kettles and boilers.

2. PROTOSULPHATE OF IRON.—If a crystal of this salt be introduced into a phial filled with the water to be examined, and the phial be well corked, a yellowish-brown precipitate (sesquioxide of iron) will be deposited in a few days, if Oxygen gas be contained in the water.

3. LITMUS.—Infusion of litmus or syrup of violets is reddened by a free Acid.

4. LIME WATER.—This is a test for Carbonic Acid, with which it causes a white precipitate (carbonate of lime) if employed before the water is boiled.

5. CHLORIDE OF BARIUM.—A solution of this salt usually yields, with well-water, a white precipitate, insoluble in nitric acid. This indicates the presence of Sulphuric Acid (which, in common water, is combined with lime).

6. OXALATE OF AMMONIA.—If this salt yield a white precipitate, it indicates the presence of Lime (carbonate and sulphate).

7. NITRATE OF SILVER.—If this occasion a precipitate insoluble in nitric acid, the presence of Chlorine may be inferred.

8. PHOSPHATE OF SODA.—If the lime contained in common water be removed by ebullition and oxalic acid, and to the strained and transparent water, Ammonia and Phosphate of Soda be added, any Magnesia present will, in the course of a few hours, be precipitated in the form of the white ammoniacal phosphate of magnesia.

9. TINCTURE OF GALLS.—This is used as a test for Iron, with solutions of which it forms an inky liquor (tannate and gallate of iron). If the test produce this effect on the water before, but not after, boiling, the iron is in the state of Carbonate; if after as well as before, in that of Sulphate. *Ferrocyanide of Potassium* may be substituted for galls as a test for iron, with solutions of the sesquisalts of which it yields a blue precipitate, and with the protosalts a white precipitate, which becomes blue by exposure to the air.

10. HYDROSULPHURIC ACID (*Sulphuretted Hydrogen*).—This yields a dark (brown or black) precipitate (a metallic sulphuret) with water containing Iron or Lead in solution.

11. EVAPORATION AND IGNITION.—If the water be evaporated to dryness, and ignited in a glass tube, the presence of organic matter may be inferred by the odour and smoke evolved, as well as by the charring. Another mode of detecting organic matter is by adding nitrate of lead to the suspected water, and collecting and igniting the precipitate; when globules of metallic lead are obtained if organic matter be present. The putrefaction of water is another proof of the presence of this matter. Nitrate of silver has been before mentioned as a test[i].

β. *AQUA MARINA.—SEA WATER.*

(Aqua Maris.)

Under this head are included the waters of the ocean, and of those lakes, called inland seas, which possess a similar composition. The

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[h] See p 83, foot note.

[i] See p. 257.

Dead Sea, however, differs exceedingly in its nature from sea water, and may properly be ranked amongst mineral waters.

The quantity of solid matter varies considerably in different seas, as the following statement from Pfaff[k] proves :—

10,000 *parts of Water of*		*Solid Constituents.*
The Mediterranean Sea		410 grs.
English Channel		380 „
German Ocean	At the Island of Föhr	345 „
	„ „ Norderney	342 „
	In the Frith of Forth	312 „
	At Ritzebüttel	312 „
Baltic Sea....	At Apenrade, in Sleswick	216 „
	At Kiel, in Holstein	200 „
	At Doberan, in Mecklenberg	168 „
	At Travemünde	167 „
	At Zoppot, in Mecklenberg	76 „
	At Carlshamm	66 „

We shall not be far from the truth if we assume that the average quantity of saline water is 3½ per cent. ; and the density about 1·0274.

The composition of sea water varies in different localities, as the following analyses[l] show :

Sea Water.	*Of the English Channel,* (SCHWEITZER.) *Grains.*		*Mediterranean.* (LAURENS.) *Grains.*
Water	964·74372		959·26
Chloride of Sodium	27·05948		27·22
„ „ Potassium	0·76552		0·01
„ „ Magnesium	3·66658		6·14
Bromide of Magnesium	0·02929		—
Sulphate of Magnesia	2·29578		7·02
„ „ Lime	1·40662		0·15
Carbonate of Lime	0·03301	and Magnesia	0·20
	1000·00000		1000·00

Iodine has been found in the Mediterranean by Balard.

PHYSIOLOGICAL USES AND EFFECTS.—Sea water, taken internally, excites thirst, readily nauseates, and, in full doses, occasions vomiting and purging. The repeated use of it, in moderate doses, has been found beneficial, on account of its alterative and resolvent operation in scrofulous affections, especially glandular enlargements and mesenteric diseases. Its topical action is more stimulant than common water. It is used as an embrocation in chronic diseases of the joints. Employed as a bath, it more speedily and certainly causes the reaction and glow ; and, consequently, the sea-water bath may be used for a longer period, without causing exhaustion, than the common water bath. It is a popular opinion, which is perhaps well founded, that patients are less likely to take cold after the use of salt water, as a bath, than after the employment of common water[m].

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[k] Schwartze's *Allgemeine und specielle Heilquellenlehre*, 2te Abt. S. 186. Leipzig, 1839.

[l] *Lond. and Edin. Phil. Mag.* vol. xv. p. 51, July 1839. Also, Graham's *Elements of Chemistry*, vol. i. p. 266.

From sea water is procured Sulphate of Magnesia.

BALNEUM MARIS FACTITIUM; *Artificial Sea-Water Bath.*—A solution of one part of common salt (Chloride of Sodium) in thirty parts of water is a cheap substitute for a sea-water bath. When, however, a more faithful imitation of sea water is desired, the following formula[n] may be used:—Common Salt, 390 grs.; Crystallized Sulphate of Soda, 172 grs.; Crystallized Chloride of Calcium, 36 grs.; Crystallized Chloride of Magnesium, 144 grs.; Water, 1 wine quart. If to these, 1 grain of Iodide of Potassium, and the like quantity of Bromide of Potassium, be added, the imitation will be still more faithful.

γ. *AQUÆ MINERALES.—MINERAL WATERS.*

HISTORY.—Mineral waters were known to mankind in the most remote periods of antiquity, and were employed, medicinally, both as external and internal agents, for the prevention, alleviation, and cure of diseases. Homer[o] speaks of tepid and cold springs. The Asclepiadeæ, or followers of Æsculapius, erected their temples in the neighbourhood of mineral and thermal waters[p]. Hippocrates[q] speaks of mineral waters, though he does not prescribe them when speaking of particular diseases. Pliny[r] notices their medical properties.

NATURAL HISTORY.—The principal source of mineral waters is the atmosphere, from which water is obtained in the form of rain, snow, hail, and dew, and which after percolating a certain portion of the earth, and dissolving various substances in its passage, reappears on the surface at the bottom of declivities (*spring water*), or is procured by sinking pits or wells (*well water*). But springs are sometimes observed under circumstances which are inconsistent with the supposition of their atmospheric origin. "The boiling springs which emerge on the verge of perpetual snows, at an altitude of 13,000 feet above the level of the sea, as in the Himalayahs, cannot be derived from the atmosphere, not to mention the peculiar relations of the Icelandic Geysers[s]." Other sources, therefore, have been sought for, and the writer just quoted enumerates three; viz. the focus of volcanic activity, the great mass of the ocean, or other masses of salt water and subterranean reservoirs.

Considered with reference to their temperature, mineral waters are divided into *cold* and *hot*. The hot or thermal waters are those which possess a temperature more or less elevated above the mean of the latitude or elevation at which they are found, and the changes of which, if any, observe no regular periods coincident with the revolutions of the seasons. Three causes have been assigned as the source of the heat of mineral waters; viz. volcanic action, now in existence; volcanic action, now extinguished, but the effects of which still remain; and, a central cause of heat, which increases as we descend from the surface to the interior of the earth[t].

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[m] On the medicinal properties of sea water, consult Logan's *Observations on the Effects of Sea Water in Scurvy and Scrophula*, Lond. 1770; and Dr. R. White, on *The Use and Abuse of Sea Water*, Lond. 1775.

[n] This formula agrees with that given by Soubeiran (*Nouveau Traité de Pharmacie*, p. 663, t. 2me, éd. 2nde, Paris, 1840), and which is founded on Marcet's analysis of sea water.

[o] *Iliad*, xxii. 147.

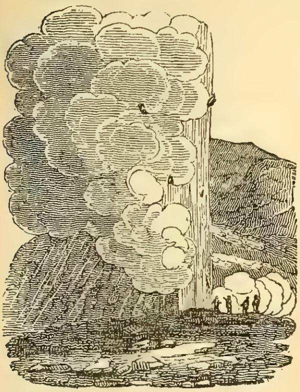
[p] Sprengel, *Hist. de Médec.* par Jourdan, t. 1er, p. 144.

[q] *De aeribus, aquis, locis.*

[r] *Hist. Nat.* lib. xxxi.

[s] Gairdner's *Essay on Mineral and Thermal Springs*, p. 289.

Fig. 49.



New Geyser.

The *Geysers*, or boiling springs, of Iceland, are evidently connected with volcanic action. They are intermittent fountains, which throw up boiling water and spray to a great height into the air[u].

The origin of the saline and other constituents is another interesting topic of inquiry connected with the natural history of mineral springs. As water in its passage through the different strata of the earth must come in contact with various substances which are soluble in it, we refer certain constituents of mineral waters to solution and lixiviation merely: as chloride of sodium, carbonates of lime and magnesia, iodides and bromides of sodium and magnesium, iron, silica, &c. Chemical action must, in some cases, be the source of other constituents. Thus sulphuretted hydrogen is probably produced by the action of water on some metallic sulphuret (especially iron pyrites): sulphurous and sulphuric acid, from the oxidation and combustion of sulphur, free or combined. The carbonic acid found in the acidulous or carbonated waters is referable to the decomposition of carbonate of lime, either by heat or by the action of sulphuric acid. Hydrochloric acid is doubtless produced by the decomposition of some chloride or muriate (probably chloride of sodium or sal ammoniac). Carbonate of soda must also be considered as the product of some chemical process; thus, that found in the natron lakes of Egypt is supposed to be formed by the action of chloride of sodium on carbonate of lime[v]. "The different orifices of the Karlsbad Sprudel discharge annually about 13,000 tons of carbonate of soda, and 20,000 of the sulphate in the crystallized state[w]:" but a "very simple calculation is sufficient to shew, that the Donnersberg alone, the loftiest of the Bohemian Mittelgebirge, a cone of clinkstone

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[t] Gairdner, *op. cit.*

[u] For further information concerning them, I must refer to Sir G. S. Mackenzie's *Travels in Iceland during the Summer of* 1810, Edinb. 1811; and to Barrow's *Visit to Iceland, by way of Tronyem, &c. in the Summer of* 1834, Lond. 1835.

[v] Berthollet, *Essai de Statique Chimique*, 1^er^ part. p. 406.

[w] Gairdner, *op. cit.* p. 325.

2,500 feet in elevation, contains soda enough to supply the Karlsbad waters alone for more than 30,000 years[x]."

Division and Properties.—Mineral waters may be classified according to their temperature, their chemical composition, or their medicinal properties. But hitherto no satisfactory classification has been effected by any of these methods, nor perhaps can it be formed. The most convenient arrangement is that founded on chemical composition, and which consists in grouping mineral waters in four classes.

CLASS 1. CHALYBEATE OR FERRUGINOUS WATERS.

(Aquæ ferruginosæ seu martiales.)

These are mineral waters whose predominating or active principle is Iron. Most mineral waters contain this metal, but the term chalybeate is not applied to them unless the quantity of iron be considerable in proportion to the other constituents. These waters have an inky or styptic taste, and become purplish black on the addition of tannic or gallic acid (or substances, as galls and tea, which contain one or both of these acids). Waters which contain the protosalts of iron yield, on the addition of ferrocyanide of potassium, a white precipitate, which becomes blue by exposure to the air. Those which contain the sesquisalts of iron give a blue precipitate with ferrocyanide of potassium, and become red on the addition of sulphocyanide of potassium.

Chalybeate waters are of two kinds, carbonated and sulphated.

Order 1. Carbonated Chalybeate Waters.—These waters contain the carbonate of the protoxide of iron. By exposure to the air, or by boiling, they attract oxygen, evolve carbonic acid, and deposit the whole of the iron in the form of sesquioxide.

When the carbonate of iron is associated with a large quantity of carbonic acid, which renders the waters brisk, sparkling, and acidulous, they are denominated *highly carbonated* or *acidulo-carbonated chalybeates*, or *acidulo-ferruginous waters*. The Spa and Pyrmont waters are of this kind. When, however, the quantity of carbonic acid is not large, and the waters do not sparkle in the glass, they are termed *simply carbonated chalybeates*, or, from the earthy and alkaline salts which they contain, *saline carbonated chalybeates*. The waters of Tunbridge Wells, Oddy's saline chalybeate at Harrowgate, and the Islington Spa near London, are of this kind.

Order 2. Sulphated Chalybeates.—These contain sulphate of iron. Neither exposure to the air nor boiling precipitates all the iron, and in this respect the sulphated chalybeates are distinguished from the carbonated ones. Some of them contain sulphate of alumina, and are denominated *aluminous sulphated chalybeates*. Of these the Sand Rock Spring, in the Isle of Wight, the Strong Moffat Chalybeate, Vicar's Bridge Chalybeate, and the Passy waters, are examples. The waters of Buckowina, in Silesia, are of this kind; but they contain also chloride of iron. Those sulphated chalybeates which are devoid of sulphate of alumina, may be termed *simply sulphated chalybeates*.

The Chalybeate waters operate in a similar manner to the other ferruginous compounds hereafter to be noticed. They are stimulant, tonic, and astringent. By repeated use they cause blackening of the stools. The acidulated carbonated chalybeates sit more easily on the stomach than other ferruginous agents, in consequence of the excess of carbonic acid which they contain. The aluminous chalybeates are very apt to occasion cardialgia, especially if taken in the undiluted state. The use of this class of waters is indicated in cases of debility, especially when accompanied with that condition of system denominated anæmia. They have long obtained a high celebrity for the relief of complaints peculiar to the female sex. Their employment is contra-indicated in plethoric, inflammatory, and febrile conditions of system.

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[x] Ibid. p. 338.

CLASS 2. SULPHUREOUS OR HEPATIC WATERS.

(Aquæ Sulphureæ seu Hepaticæ.)

These waters are impregnated with hydrosulphuric acid (sulphuretted hydrogen); in consequence of which they have the odour of rotten eggs, and cause black precipitates (metallic sulphurets) with solutions of the salts of lead, silver, copper, bismuth, &c. Those sulphureous waters which retain, after ebullition, their power of causing these precipitates, contain a sulphuret (hydrosulphuret) in solution, usually of calcium or sodium. All the British sulphureous waters are cold, but some of the continental ones are thermal. The most celebrated sulphureous waters of England are those of Harrowgate[y]; those of Scotland are Moffatt and Rothsay; of the continent, Enghein, Barèges, Aix, Aix-la-Chapelle, and Baden.

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF SULPHURETTED HYDROGEN IN SULPHUREOUS WATERS.

	100 *Cubic inches of the Water of*	*Cub. inches of Gas.*	*Authority.*
THERMAL	Barèges in the Pyrenees, contains	20·0	Lüdemann.
	Cauterets in ditto	50·0	Ditto.
	St. Sauveur in ditto	16·6	Ditto.
	Schinznach in C. Aargau in Switz.	30·11	Peschier.
	Aachen in the Lower Rhine	45·78	Monheim.
	Warmbrunn in Silesia	17·17	Osann.
	Landeck in county of Glatz	14·88	Ditto.
	Baden near Vienna	11·83	Ditto.
COLD	Harrowgate in England (old well)	5·94	Scudamore[z].
	Moffat in Scotland	7·58	Thomson.
	Strathpeffer in ditto (upper well)	9·44	Ditto.
	Enghein in France	1·60	Longchamps.
	Nenndorff in Hesse	40·90	Osann.
	Winslar in Hanover	51·51	Ditto.
	Eilsen in Lippe	27·21	Ditto.
	Meinberg in ditto	30·91	Ditto.
	Weilbach in Nassau	22·32	Ditto[a].
	Berka in Thuringia	20·60	Ditto.
	Bocklet in Franconia	17·17	Ditto.
	Doberan in Mecklenburg	18·20	Ditto.
	Bentheim in Germany	15·45	Ditto.
	Sironabad in Hesse	2·63	Büchner.
	Dinkhold in Nassau	8·6	Kolb.

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[y] See Dr. A. Hunter's *Treatise on the Mineral Waters of Harrowgate.* Lond. 1830.

[z] I have not admitted the waters of Cheltenham into this list, in consequence of the extreme inconstancy of the sulphureous impregnation. Other reasons, however, render it very doubtful if any of the analyses of some of the recent springs represent their *natural* composition.—M. G.

[a] 30·9 Creve (*Stiffts Nassau,* p. 577).—M. G.

The general operation of these waters is stimulant, and is adapted for chronic complaints [b]. They are supposed to possess a specific power over the cutaneous and uterine systems. They are employed both as external and internal agents; in chronic skin diseases (as lepra, psoriasis, scabies, pityriasis, herpes, &c.)—in derangements of the uterine functions (amenorrhœa and chlorosis)—in old syphilitic cases—in chronic rheumatism and gout, and in other diseases in which sulphur or its compounds have been found serviceable, and which will be noticed hereafter. On account of their stimulant effects, they are contra-indicated in all plethoric and inflammatory conditions of the system, and their employment requires caution, especially in weak and irritable constitutions.

CLASS 3. ACIDULOUS OR CARBONATED WATERS.

(Aquæ Acidulæ.)

These waters owe their remarkable qualities to carbonic acid gas, which gives them an acidulous taste, a briskness, a sparkling property, and the power of reddening litmus slightly, but fugaciously, and of precipitating lime and baryta waters. When they have been exposed to the air for a short time, this gas escapes from them, and the waters lose their characteristic properties.

Most mineral and common waters contain a greater or less quantity of free carbonic acid. Ordinary spring or well waters do not usually contain more than three or four cubic inches of carbonic acid gas in 100 cubic inches of water. Dr. Henry found, in one experiment, 3·38 inches [c]. But the waters called acidulous or carbonated contain a much larger quantity. Those which have from 30 to 60 cubic inches of gas are considered rich; but the richest have from 100 to 200 or more inches [d]. Alibert [e] states, that the waters of Saint-Nectaire contain 400 cubic inches in 100 of the water.

Most of the waters of this class contain carbonate or bicarbonate of soda: these are termed *acidulo-alkaline*. The Selters [f] (often called Seltzer), Altwasser, Saltzbrunn, Reinerz, and Pyrmont waters, are of this kind. Frequently they contain carbonate of the protoxide of iron also: they are then termed the *acidulous carbonated chalybeates*, which have been already noticed.

The only acidulous or carbonated spring in Great Britain is that of Ilkeston, near Nottingham, and which has been described by Mr. A. F. A. Greeves [g], and by Dr. T. Thomson [h].

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[b] See some *Observations on the Efficacy of Sulphureous Waters in Chronic Complaints*, by Dr. J. Armstrong, in his *Practical Illustrations of the Scarlet Fever*, 2d ed. Lond. 1818.

[c] Thomson's *System Chem.* vol. iii. p. 193, 6th edit.

[d] Gairdner, *op. cit.* p. 30.

[e] *Nouveaux Elémens de Thérapeutique*, tom. 3$^{\text{me}}$, p. 517, 5$^{\text{me}}$ éd.

[f] See some *Experiments relative to the Analysis and Virtues of Seltzer Water*, by Dr. Brocklesby, in the *Medical Observations and Inquiries*, vol. iv. p. 7, 2d ed. Lond. 1772.

[g] *Account of the Medicinal Water of Ilkeston*, 1833.

[h] *Cyclopædia of Practical Medicine*, art. *Waters, Mineral.*

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF CARBONIC ACID IN ACIDULOUS WATERS.

	100 *Cubic inches of Water of*	*Cub. inches of Gas.*	*Temp.*	*Authority.*
THERMAL	Bath in England, contains	4·16	114° F.	Phillips.
	Bristol in do.	12·99	74	Carrick.
	Buxton in do.	0·649	82	Scudamore.
	St.-Nectaire in France	400·0	75	Alibert[i].
	Karlsbad in Bohemia	110·0	165	Berzelius.
	Gurgitello in Ischia	89·14	122	Giudice[j].
	Carratraca in Spain	10·70	66	Alibert.
	Maschuka in the Caucasus	60·9	118	Hermann.
	Eisenberg in do.	32·7	103	Ditto.
	Petersquellen in do.	2·0	195	Ditto.
	Schlengenbad in Nassau (Schachtbrun)	6·0	87	Kastner.
	Ems in do. (Kränchesquelle)	59·9	86	Ditto.
	Ditto (at Wall of Lahn)	42·1	123	Ditto.
	Wiesbaden in do. (No. 1.)	19·7	158	Ditto.
COLD	Tunbridge in England	3·485	..	Scudamore[k].
	Harrowgate in do. (old sulphur well)	4·125	..	Ditto.
	Cheltenham in do. (old well)	12·50	..	Fothergill, 1788.
	Pitcaithly in Scotland	3·463	..	Murray.
	Andabra in France	100·0	..	Berard.
	Enghien les Bains in do.	0·674	..	Longchamps[l].
	Godelheim in Germany	224·9	..	Witting.
	Cudowa in county of Glatz	202·6	..	Mogalla.
	Pyrmont in Germany	151·1	..	Brandes.
	Königswarth in Bohemia	139·1	..	Wetzler.
	Schwalheim in the Wetterau	129·0	..	Wurzer.
	Bocklet in Franconia	112·5	..	Vogelmann.
	Franzensbad in Bohemia	88·67	..	Trommsdorff.
	Geilnau on the Lahn	163·2	..	Bischof.
	Fachingen on do.	134·8	..	Ditto.
	Selters in Nassau (Nieder)	108·7	..	Ditto.
	Liebenstein in Thuringia	109·9	..	Trommsdorff.
	Tarasp in Switzerland	109·9	..	Capeller.
	Kissingen in Germany	85·85	..	Vogel.
	Imnau in Wurtemburg	89·28	..	Kielmayer.
	Alexandersbad	94·09	..	Hildebrandt.
	Bilin in Bohemia	74·69	..	Reuss.
	Schwalbach in Nassau	73·83	..	Rube.
	Spaa in Germany	74·45	..	Monheim.
	Ballstown, State of New York	300·0	..	Hosack.
	Kislawodsk in the Caucasus	151·2	..	Hermann.
	Dinkhold in Nassau	143·9	..	Kolb.
	Oberlahnstein in do.	55·6	..	Amburger.
	Marienfels in do.	92·5	..	Kastner.
	Soden in do.	88·0	..	Meyer.
	Cronberg in do.	106·2	..	Ditto.
	Montabaur in do.	55·8	..	Jacobi.
	Braubach in do. (Salzborn)	58·4	..	Bruckmann.
	Langenschwalbach (Weinbrunn)	89·1	..	Kastner.
	Marienbad in Bohemia (Kreutzbr.)	125·0	..	Struve.
	Saidschütz in do.	20·9	..	Ditto.
	Püllnas in do.	6·9	..	Ditto[m].

Those acidulous waters which owe their medicinal activity principally to the carbonic acid which they contain, act chiefly on the digestive, renal, and nervous systems; but their effects are transient. They are cooling, refreshing, and exhilarating, and frequently relieve nausea. They augment and alter the renal secretion. Sometimes they occasion a sensation of fulness in the head, or even produce slight temporary intoxication. They are used in some disordered conditions of the digestive organs, especially when connected with hepatic derangement, in dropsical complaints, in uterine affections, and in various other cases, which will be more fully noticed when treating of carbonic acid. When the acidulous waters contain the protocarbonate of iron, their effects and uses are analogous to those of the ferruginous springs already noticed. The aciduio-alkaline waters are useful in the lithic acid diathesis, in gout and rheumatism, &c. The acidulous or carbonated waters are objectionable, on account of their stimulating effects, in febrile, inflammatory, and plethoric subjects.

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[i] I have assumed the coldest spring to be that which contains this large quantity of gas, which is not particularly specified; there are seven springs, ranging from 74°—104° F.—M. G.

[j] Viaggio Medico. Half of the acid escapes at 144°, and the whole at 167°.—M. G.

[k] After being heated to 144° F. it contained 2·736.—M. G.

[l] Parts by weight in 10,000 of water.—M. G.

[m] In all these instances the carbonic acid was obtained by boiling, which expels not only the acid which is in an uncombined state in the natural water, but also the excess, which goes to convert the carbonates of acidulous waters into bicarbonates.—M. G.

CLASS 4. SALINE WATERS.

(Aquæ Salinæ.)

These waters owe their medicinal activity to their saline ingredients; for although they usually contain carbonic acid, and sometimes oxide of iron or hydrosulphuric acid, yet these substances are found in such small quantities as to contribute very slightly only to the medicinal operation of the water.

Saline mineral waters may be conveniently divided into five orders, founded on the nature of the predominating ingredient.

Order 1. Purging saline waters. — The leading active ingredient of the waters of this order is either the sulphate of soda or the sulphate of magnesia; but the chlorides of calcium and magnesium, which are usually present, contribute to their medicinal efficacy. Those springs, in which the sulphate of magnesia predominates, are called *bitter*—as those of Epsom, Scarborough[i], Seidlitz, Saidschütz, and Pullna. The springs of Cheltenham[j], Leamington[k], and Spital, contain sulphate of soda. In full doses the waters of this order are mild cathartics. In small and repeated doses they act as refrigerants and alteratives. They are useful in diseased liver, dropsical complaints, habitual constipation, hemorrhoids, determination of blood to the head, &c. The Karlsbad, Marienbad, and Franzensbrunn, contain carbonate as well as sulphate of soda.

Order 2. Saline or Brine Waters.—The characteristic ingredient of these waters is chloride of sodium. Iodine or bromine, or both, have been recognised in some of them, and doubtless contribute somewhat to the medicinal effects. The most important brine springs of England are those of Middlewich and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. The springs of Ashby-de-la-Zouch, in Leicestershire, contain, besides chloride of sodium, a considerable quantity of chloride of calcium. Taken in large quantities, saline or brine waters are emetic and purgative. In small but continued doses they act as alteratives, and are supposed to stimulate the absorbent system. They have been principally celebrated in glandular enlargements, especially those which are of a scrofulous nature. The waters of Wisbaden, Baden-Baden, and Bourbonne, are thermal saline waters. The water of the Dead Sea may be arranged among saline mineral waters.

Order 3. Calcareous Waters.—Those saline mineral springs whose predominating constituent is either sulphate or carbonate of lime, or both, are denominated calcareous waters. The Bath, Bristol, and Buxton thermal waters are of this kind. When taken internally, their usual effects are stimulant (both to the

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[n] See Dr. Short's *Natural, Experimental, and Medicinal History of the Mineral Waters of Derbyshire, Lincolnshire, and Yorkshire, particularly of Scarborough.* Lond. 1734.

[o] See Dr. Scudamore on Cheltenham Waters, in his work on Mineral Waters before quoted.—Also Maccabe's *Treatise on the Cheltenham Waters.* Lond.

[p] See Dr. Lambe's Analysis, in the *Manchester Memoirs*, vol. v.—Also Dr. Scudamore's work before quoted; and Dr. Loudon's *Practical Dissertation on the Waters of Leamington Spa.* 1828.

circulation and the urinary and cutaneous secretions), alterative, and constipating: and are referrible, in part, to the temperature of the water, in part to the saline constituents. Employed as baths, they are probably not much superior to common water heated to the proper temperature; but they have been much celebrated in the cure of rheumatism, chronic skin diseases, &c. Bath water[q] is generally employed, both as a bath and as an internal medicine, in various chronic diseases admitting of, or requiring, the use of a gentle but continued stimulus; as chlorosis, hepatic affections, gout, rheumatism, lepra, &c. Buxton water, taken internally, has been found serviceable in disordered conditions of the digestive organs, consequent on high indulgence and intemperance; in calculous complaints, and in gout: employed externally, it has been principally celebrated in rheumatism[r]. The water of Bristol Hot-well is taken in dyspeptic complaints and pulmonary consumption[s].

Order 4. Alkaline Waters.—The mineral waters denominated alkaline, contain carbonate or bicarbonate of soda as their characteristic ingredient. The springs of Teplitz[t], Ems, and Vichy[u], belong to this order. They pass insensibly into, and are, therefore, closely related to, the waters of the preceding classes. Thus, springs which contain carbonate of soda, with a considerable excess of carbonic acid (as those of Carlsbad[v] and Selter), are denominated *acidulo-alkaline*, and have been already noticed among the *acidulous* or *carbonated waters*. Those in which carbonate of soda is associated with protocarbonate of iron and excess of carbonic acid, have been referred to under the head of *acidulous carbonated chalybeates*. The only waters in this country which contain carbonate of soda, are those of Malvern[w], in Worcestershire; and Ilkeston, in Derbyshire, near Nottingham; but the quantity in both cases is very small. The first, which is a very pure water, contains only 0·61 parts of the carbonate in 10,000 of the water, and the second 3·355 grains in an imperial gallon. For external use, the alkaline waters are principally valuable on account of their detergent qualities. When taken internally, they act on the urinary organs. They may be employed in calculous complaints connected with lithic acid diathesis, in gout, in dyspepsia, &c.

Order 5. Siliceous Waters.—Most mineral waters contain traces of silica, but some contain it in such abundance that they have been denominated siliceous. Thus, in the boiling springs of Geyser and Reikum, in Iceland, it amounts to nearly one-half of all the solid constituents. In these waters the silica is associated with soda (silicate of soda), sulphate of soda, and chloride of sodium[x]. I am unacquainted with their action on the body. It is probably similar to that of the alkaline waters.

For the following table of the composition of some of the most celebrated mineral waters, I am indebted to Dr. Gairdner's work[y]:—

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[q] For an account of the Bath waters, see Wm. Oliver, *A Practical Dissertation on Bath Waters*. Bath, 1716.

Dr. Sutherland, *Natural History, Analysis, and General Virtues of the Bath and Bristol Waters*. Lond. 1763.

Dr. Falconer, *A Practical Dissertation on the Medicinal Effects of the Bath Waters*. Bath, 1790.

Dr. Gibbes, *A Treatise on the Bath Waters*, 1800.—Another edition, 1812.

Dr. E. Barlow, *Essay on the Bath Waters*. Lond.

Mr. Spry, *A Practical Treatise on the Bath Waters*. Lond. 1822.

[r] On the Buxton Waters, see an anonymous *Treatise on the Nature and Virtues of Buxton Water*, Lond. 1761; Dr. G. Pearson's *Observations and Experiments for investigating the Chemical History of the Tepid Springs at Buxton*, Lond. 1784; Dr. James Denman's *Observations on the Effects of Buxton Water*, Lond. 1793; Mr. W. H. Robertson's *Medicinal Property of Buxton Water*, Lond. and Sir C. Scudamore's work already quoted.

[s] Consult Dr. Carrick's *Dissertation on the Chemical and Medical Properties of the Bristol Hot-well Water*. Bristol, 1797.

[t] *Die Bäder von Teplitz*, von A. Reuss. Teplitz, 1835.

[u] See p. 214.

[v] See Kreysig's *Internal Use of Waters of Carlsbad*. Lond. 1824.

[w] For an account of the Malvern waters, see Dr. J. Wall's *Experiments and Observations on the Malvern Waters*. Worcester, 1763; Dr. M. Wall's *Malvern Waters*, Oxford, 1806; and Mr. Addison's *Dissertation on the Nature and Properties of the Malvern Water*. Lond. 1828.

[x] See Dr. Black's analysis, in the *Trans. of the Royal Soc. of Edin.* vol. iii; also, Faraday's, in Barrow's *Visit to Iceland*.

[y] *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs*. Lond. 1832.

FIXED CONSTITUENTS

ENTERING INTO THE COMPOSITION OF SOME OF THE MORE CELEBRATED

MINERAL SPRINGS.

Proportions in 10,000 Parts of Water.

Note.—In reducing the analyses contained in this Table to a uniform measure, in order to render them susceptible of direct comparison with each other, I have assumed the old English gallon as = 58,338 grains: the wine pint = 7305 grs.; the imperial gallon = 70,000 grs.; and the German 16-ounce measure = 7368 grs.

The different salts have been reduced to their elementary constituents by Wollaston's scale of chemical equivalents.

THERMAL.													
Name.	Country.	Acids.			Bases.			Oxide of Iron.	Silica.	Sum.	Authority and Date.	Remarks.
		Carbonic.	Sulphuric.	Muriatic.	Soda.	Lime.	Magnesia.					
San Restituta	Ischia	0	19·30	29·05	34·50	2·08	2·35	3·19	0·40	94·44	Giudice	Iron in the state of ferruginous alumina; sub-borate of soda 2·79.
Gurgitello	Ditto.	14·55	9·05	11·18	31·45	2·95	2·38	1·39	0·56	74·03	Ditto.	Iron as in San Restituta.
Wiesbaden	Nassau	1·38	0·87	33·09	31·99	5·29	0·92	0·05	0·26	57·63	Kastner, 1823.	Free carbonic acid 18·9; azote; potash 0·83; alumina 0·56; organic extract 2·37.
Carlsbad Sprudel	Bohemia	7·45	14·50	6·40	24·55	1·75	0·85	0·02	0·75	54·59	Berzelius, 1822	Minute traces of phosphoric and fluoric acids, strontian, alumina, and manganese.
St. Nectaire	France	15·13	0·87	13·00	23·90	2·45	1·14	0·14	1·00	53·94	Berthier	
Vichy	Ditto	15 81	1·55	0·72	24·47	0·27	0	0·01	0	42·75	Ditto	
Ems (Kränchesquelle)	Nassau	20·32	0·76	2·43	14·87	2·65	1·45	0·65	trace	42·74	Kastner, 1830	Alumina, a trace; oxide of manganese 2·42
Olmitello	Ischia	0	6·91	5·95	5·98	0	1·80	0	0·42	24·43	Giudice	Potash 2·73.
Bath (King's Bath)	England	2·38	8·71	0	2·79	5·29	0·77	0·03	0·37	20 53	Phillips	The magnesia by Scudamore.
Mont d'Or	France	2·86	0·36	2·05	4·74	0·90	0·28	0·10	2·10	13·39	Berthier	
Geyser	Iceland	0	0·81	1·32	2·74	0	0	0	5·40	10·75	Black, 1791	Alumina 0·48.
Chaudes Aigues	France	3·07	0	0·86	3 12	1·01	0·59	0·15	1·16	9·96	Berthier	
Rycum [Reikum]	Iceland	0	0·71	1·55	2·43	0	0	0	3·73	8·47	Black, 1791	Alumina 0·05.
Bristol Hot-well	England	1·02	2·25	1·17	1·17	0·82	0·43	0	0	8·19	Carrick, 1797	Free carbonic acid 12·99.
Schlangenbad	Nassau	3·50	0	0·80	2·42	0·90	0·53	0	0	6·96	Kastner, 1823	Free carbonic acid 6·0.
Teplitz	Bohemia	1·89	0·40	0·29	2·62	0·36	0·18	0·03	0·42	6·24	Berzelius, 1822	Phosphoric acid; potash; alumina.
Buxton	England	0·78	0·06	0·28	0·19	1·04	0·04	0	0	2·70	Scudamore, 1820	Azote 2·01, by Pearson.

COLD.

Vicar's Bridge	Scotland	0	203·00	0·18	0·16	2·56	13·2	103·00	0	563·10	Connell, 1831	Potash, a trace.
Pullnas	Bohemia	4·63	182·83	17·20	75·00	20·38	45·45	0	0 24	341·1	Struve	Potash 3·55.
Saidschutz	Ditto	4·81	97·43	1·43	14·20	6·02	41·92	trace	0 16	177·4	Ditto	Nitric acid 7·75; phosphoric acid; potash 3·61; strontian 0·03; alumina; oxide of manganese.
Leamington (Royal Pump)	England	0	20·80	71·90	57·90	12·00	4·95	1·09	0	153·9	Thomson, 1830	Traces of iod. & brom. by Daubeny.
Harrowgate (old sulphur well)	Ditto	1·20	0·80	76·83	60·50	4·47	1·94	0	0	145·4	Scudamore, 1819	
Airthrey (first spring)	Scotland	0	4·25	76·46	32·10	32·50	0·31	0	0	127·4	Thomson, 1828	
Cheltenham (old well)	England	0	11·05	50·65	45·80	4·26	1·22	trace	0	111·6	Scudamore, 1819	Trace of iodine by Daubeny.
Hartfell aluminous chalyb.	Scotland	0	63 23	0	0	0	0	40·00	0	101·3	Thomson, 1828	Alumina 5·10.
Isle of Wight	England	0	48·58	2·95	6·85	5·68	0·82	14·60	0 96	88·21	Marcet	Alumina 7·77.
Marienbad (Ferdinands-quelle)	Bohemia	9·52	27·60	9·50	38·05	2·87	1·67	0·12	0·50	86·18	Steinmann, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius
Dunblane (north spring)	Scotland	0·30	2·23	33·55	15·30	14·04	0	0·23	0	63·21	Murray, 1814	
Vals	France	22·48	0·29	3·00	33·34	1·60	0·22	0·06	0·45	61·17	Berthier	
Bilin	Bohemia	20·51	3·40	1·44	28 47	2·47	1·60	0·10	0	57·46	Reuss, 1788	
Franzenbad (Franzens-brunn)	Ditto	5·44	18·50	6·21	26·70	1·26	0	0·37	0·48	55·80	Tromsdorff, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius
Pitcaithly	Scotland	0·30	0·73	27·20	8·50	13·99	0	trace	0	46·95	Murray, 1814	
Roisdorf	Rhenish Prussia	6·76	2 50	9·70	16·00	1·78	1·33	0·07	0·21	38·11	Bischof, 1826	Potash.
Epsom	England	2·50	14·80	4·21	5·64	11·80	0	0	0	37·94	Daubeny, 1830	Trace of bromine.
Selters (Nieder)	Nassau	5·37	0·18	9·92	16·06	1·37	1·00	0·12	0·38	34·00	Bischof, 1826	Phosphoric acid 0·19.
Fachingen	Ditto	11·49	0·12	2·63	15·63	1·83	1·09	0·07	0·11	32·98	Ditto	Phosphoric acid 0·005.
Soden	Ditto	3·35	0·07	12·30	10·72	4·08	0·06	0·08	0.06	30·89	Meyer, 1820	
Moffat	Scotland	0	2·80	13·60	12·75	0·68	0·26	0	0	30·03	Thomson, 1828	
Pyrmont	Germany	4·03	9·83	0·99	1·29	8·56	1·98	0·36	0·68	27·89	Struve	Phosphoric acid, potash, strontian, manganese.
Marienfels	Nassau	4·83	0·18	1·88	3·42	2·20	1·27	0·10	trace	15·99	Kastner	Potash 1·19; strontian, manganese, phosphoric acid.
Strathpeffer (pump-room),	Scotland	0	9 32	2·17	6·18	2·33	0·30	0	0	15·36	Thomson, 1828	Potash?
Geilnau	Nassau	6·00	0·07	0·18	5·08	1·46	1·40	0·13	0·14	14·66	Bischof, 1826	Phosphoric acid 0·19.
Weilbach	Ditto	3·61	0·81	1·31	4·60	1·55	2·05	0	0	14·40	Creve, 1810	Sulphur-resin 0·48.
Hartfell Spa	Scotland	0	2·76	3·05	0	2·30	0	2·49	0	9·95	Thomson, 1828	Alumina, a trace.
Langenschwalbach (We-inbrunn)	Nassau	3·84	0·12	0·12	0·34	1·55	1·95	0·67	trace	8·58	Kastner, 1829	Potash, lithion, iodine, strontian, alumina, manganese, phosph^{c}. acid.
Spa	Germany	6·63	0·51	0·33	0·92	0·74	0 ·72	7·90	0·68	5·92	Struve	Phos. acid; potash 0·58; manganese
Carlsbad (Sauerling)	Bohemia	0·28	0·13	0·07	0·28	0·16	0·06	0·06	0·61	1·42	Berzelius, 1822	Phosphoric acid, fluate of lime, alumina, oxide of manganese.
Tunbridge	England	0·20	0·14	0·29	0·19	0·39	0·02	0·38	0·07	1·32	Scudamore, 1816	Oxide of manganese.
Malvern	Ditto	0·32	0·14	0·08	0·55	0·03	0·02	0·04	0	1·01	Phillip, 1805	

For further details, respecting mineral waters in general, the reader is referred to the following works:—

Dr. J. Rutty, *Methodical Synopsis of Mineral Waters.* Lond. 1757.
Dr. D. Munro, *Treatise on Mineral Waters.* Lond. 1770.
Dr. W. Saunders, *Treatise on the Chemical History and Medical Powers of some of the most celebrated Mineral Waters.* Lond. 1800.
C. F. Mosch, *Die Bäder und Heilbrunnen Deutschlands und der Schweiz.* Leipzig, 1819.
Alibert, *Précis historique sur les Eaux Minérales.* Paris, 1826. Also, in his *Nouveaux Elémens de Thérapeutique,* 3me tom. 5me éd. Paris, 1826.
E. Osann, *Physikalisch-medicinische Darstellung der bekannten Heilquellen der vorzüglichsten Länder Europa's.* Berlin, 1er Theil, 1829. 2er Theil, 1832.
Dr. T. Thomson, *Cyclopædia of Practical Medicine,* art. *Waters, Mineral,* vol. iv. Lond. 1835.
Mr. Lee, *An Account of the most frequented Watering Places on the Continent.* Lond. 1836.
Patissier et Bourtron-Charlard, *Manuel des Eaux Minérales Naturelles,* 2nde ed. Paris, 1837.
Dr. A. B. Granville, *The Spas of Germany,* Lond. 1837. 2nd éd. 1838.
G. W. Schwartze, *Allgemeine und specielle Heilquellenlehre.* Leipzig, 1839.
Mr. Lee, *Principal Baths of Germany,* 1840.
Dr. J. Johnson, *Pilgrimage to the Spas.* Lond. 1841.
Dr. A. B. Granville, *The Spas of England,* Northern, Midland, and Southern. 1841.

ARTIFICIAL MINERAL WATERS.—In this country the demand for artificial mineral waters is exceedingly limited, and I do not, therefore, think it necesssary to enter into any details respecting their manufacture; but shall content myself with referring those interested in the matter to the works of Soubeiran[z] and Guibourt[a] for full details[b].

3. AC′IDUM HYDROCHLO′RICUM.—HYDROCHLORIC ACID.

History and Synonymes.—Liquid hydrochloric acid was probably known to Geber, the Arabian chemist, in the eighth century. The present mode of obtaining it was contrived by Glauber. Some modern chemists term it *chlorhydric acid.* Scheele, in 1774, may be regarded as the first person who entertained a correct notion of its composition. To Sir H. Davy we are principally indebted for the establishment of Scheele's opinion.

Natural History.—It is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—Hydrochloric acid is one of the gaseous products of volcanoes. Combined with ammonia, we find it in volcanic regions.

β. In the Organised Kingdom.—Free hydrochloric acid is an essential constituent of the gastric juice in the human subject. Hydrochlorate of ammonia (sal ammoniac) was found, by Berzelius, in the urine. Chevreul states he detected free hydrochloric acid in the juice of *Isatis tinctoria.*

1. *Gaseous Hydrochloric Acid.*

Preparation.—Hydrochloric acid, in the gaseous state, is procured by the action of oil of vitriol on dried chloride of sodium. The ingredients should be introduced into a tubulated retort, the neck of which is lined with bibulous paper, and the gas collected over mercury. Or they may be placed in a clean and dry oil flask, and the gas conveyed, by means of a glass tube curved twice at right angles, into a proper receptacle, as a bottle, from which the gas expels the air by its greater gravity.

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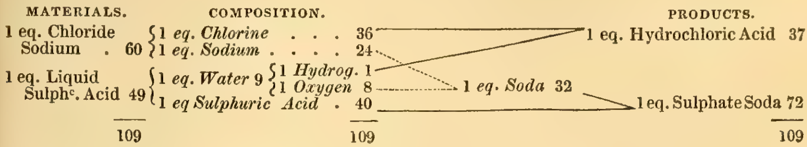
[z] *Nouveau Traité de Pharmacie,* t ii. 2nde édit. Paris, 1840.

[a] *Pharmacopée Raisonnée, ou Traité de Pharmacie pratique et theorique,* par N. E. Henry et G. Guibourt. 3me édit. revue et considérablement augmentée par N. J. B. G. Guibourt. Paris, 1841.—The *Codex Pharmacopée Française* also contains formulæ for the preparation of artificial mineral waters.

[b] The manufacture of *Sodaic* and *Magnesian Waters* will be described hereafter.

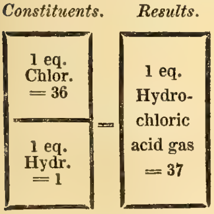
In this process, one equivalent or 60 parts of chloride of sodium react on one equivalent or 49 parts of the protohydrate of sulphuric acid (strong oil of vitriol), and produce one equivalent or 37 parts of hydrochloric acid (gas), and one equivalent or 72 parts of the sulphate of soda.



PROPERTIES.—It is a colourless invisible gas, fuming in the air, in consequence of its affinity for aqueous vapour. It is rapidly absorbed by water. Its specific gravity is, according to Dr. Thomson, 1·2847 [1·269 Berzelius]. It has a pungent odour and acid taste. Under strong pressure (40 atmospheres) it becomes liquid. It is neither combustible nor a supporter of combustion. When added to a base (that is, a metallic oxide), water and a chloride are the results. The atomic weight of hydrochloric acid is 37 [36·47 Berzelius; 36·42 Turner].

Characteristics.—Hydrochloric acid gas is known by its fuming in the air, by its odour, by its reddening moistened litmus paper, by its forming white fumes with the vapour of ammonia, and by its action on a solution of nitrate of silver, as will be mentioned when describing the liquid acid.

COMPOSITION.—The composition of this gas is determined both by analysis and synthesis. Thus, one volume of chlorine gas may be made to combine with one volume of hydrogen gas, by the aid of light, heat, or electricity, and the resulting compound is two volumes of hydrochloric acid gas. Potassium or zinc heated in this acid gas, absorbs the chlorine and leaves a volume of hydrogen.



	Atoms.	*Eq. Wt.*	*Per Ct.*		*Vol.*	*Sp. gr.*
Chlorine....	1	36	97·297	Chlorine gas	1	2·5
Hydrogen ..	1	1	2·702	Hydrogen gas......	1	0·0694
Hydrochlc. Acid. ..	1	37	100·000	Hydrochloric Acid gas..........	2	1·2847

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—Mixed with 20,000 times its volume of atmospheric air, this gas is said, by Drs. Christison and Turner[c], to have proved fatal to plants, shrivelling and killing all the leaves in twenty-four hours. But according to Messrs. Rogerson[d], it is not injurious to vegetables when mixed with 1500 times its volume of air. Dr. Christison ascribes these different results to Messrs. Rogerson having employed jars of too small size.

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[c] Christison's *Treatise on Poisons.*

[d] *London Medical Gazette*, vol. x. p. 312.

We have good evidence of the poisonous operation of this gas on vegetables in the neighbourhood of those chemical manufactories in which carbonate of soda is procured from common salt. The fumes of the acid which issue from these works have proved so destructive to the surrounding vegetation, that in some instances the proprietors have subjected themselves to actions at law, and have been compelled either to pay damages, or to purchase the land in their immediate vicinity.

β. *On Animals* this gas acts injuriously, even when mixed with 1500 times its volume of atmospheric air. Mice or birds introduced into the pure gas, struggle, gasp, and die within two or three minutes. Diluted with atmospheric air, the effects are of course milder, and in a ratio to the quantity of air present. In horses it excites cough and difficulty of breathing. When animals are confined in the dilute gas, in addition to the laborious and quickened respiration, convulsions occur before death. Messrs. Rogerson state, that " in a legal suit for a general nuisance, tried at the Kirkdale Sessions-house, Liverpool, it was proved that horses, cattle, and men, in passing an alkali-works, were made, by inhaling this gas, to cough, and to have their breathing much affected. In the case of Whitehouse *v.* Stevenson, for a special nuisance, lately tried at the Staffordshire assizes, it was proved that the muriatic acid gas from a soap manufactory destroyed vegetation, and that passengers were seized with a violent sneezing, coughing, and occasional vomiting. One witness stated, that when he was driving a plough, and saw the fog, he was obliged to let the horses loose, when they would gallop away till they got clear of it." It acts as an irritant on all the mucous membranes.

γ. *On Man* this gas acts as an irritant poison, causing difficult respiration, cough, and sense of suffocation. In Mr. Rogerson's case it caused also swelling and inflammation of the throat. Both in man and animals it has appeared to produce sleep.

The action of hydrochloric acid gas on the lungs is injurious in at least two ways: by excluding atmospheric air, it prevents the decarbonization of the blood ; and, secondly, by its irritant, and perhaps also by its chemical properties, it alters the physical condition of the bronchial membrane. The first effect of attempting to inspire the pure gas seems to be a spasmodic closure of the glottis. Applied to the conjunctiva, it causes irritation and opacity.

Use.—It has been employed as a *disinfectant*, but is admitted on all hands to be much inferior to chlorine. The Messrs. Rogerson deny that it possesses any disinfecting property. It is perhaps equally difficult either to prove or disprove its powers in this respect. The experiments of Guyton-Morveau, in purifying the cathedral of Dijon, in 1773, are usually referred to in proof of its disinfecting property. If it possess powers of this kind, they are certainly inferior to chlorine, or the chlorides [hypochlorites] of lime or soda ; but, in the absence of these, hydrochloric acid gas may be tried. In neutralizing the vapour of ammonia it is certainly powerful.

Application.—In order to fumigate a room, building, or vessel, with this gas, pour some strong oil of vitriol over dried common salt, placed in a glass capsule or iron or earthen pot, heated by a charcoal fire or hot sand.

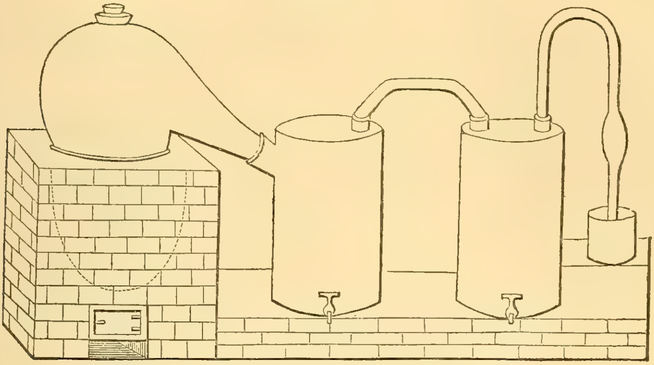
Antidote.—Inhaling the vapour of ammonia may be serviceable in neutralizing hydrochloric acid gas. Symptoms of bronchial inflammation are of course to be treated in the usual way.

2. *Liquid Hydrochloric Acid.*

(Acidum Hydrochloricum, *L.* Acidum Muriaticum, *E. D.* Hydrochloric Acid, *E.* Muriatic or Marine Acid; Spiritus Salis, or Spirit of Salt.)

Preparation.—This is obtained by submitting a mixture of Common Salt (chloride of sodium) and Oil of Vitriol to distillation in a proper apparatus, and condensing the Hydrochloric Acid gas which passes over in water contained in the receiver. Manufacturers of hydrochloric acid generally employ an iron or stoneware pot set in brickwork over a fire-place, with a stoneware head luted to it, and connected with a row of double-necked bottles, made of the same material, and furnished with stop-cocks of earthenware. The last bottle is supplied with a safety tube, dipping into a vessel of water (fig. 50).

Fig. 50.



Apparatus for making Hydrochloric Acid.

The liquid obtained by this process is yellow, and constitutes *Commercial Muriatic Acid* (*Acidum Muriaticum venale ; Hydrochloric Acid of Commerce*, Ph. Ed.).

Since the manufacture of carbonate of soda from the sulphate of soda, and the consequent necessity of obtaining the latter salt in large quantities, another mode of making hydrochloric acid has been sometimes adopted. It consists in using a semi-cylindrical vessel for the retort: the upper or flat surface of which is made of stone, while the curved portion exposed to the fire is formed of iron. The chloride of sodium is introduced at one end, which is then closed by an iron plate, perforated to allow the introduction of the leg of a curved leaden funnel, through which strong sulphuric acid is poured. The funnel is then removed, and the aperture closed. Heat being applied, the hydrochloric acid gas is developed, and is conveyed by a pipe into a double-necked stoneware bottle, half filled with water, and connected with a row of similar bottles likewise containing water.

The British Pharmacopœias give directions for making hydrochloric acid. The *Edinburgh College* directs the common salt to be previously purified—

> "by dissolving it in boiling water; concentrating the solution; skimming off the crystals as they form on the surface; draining from them the adhering solution as much as possible; and, subsequently, washing them with cold water slightly."

The *London College* uses Chloride of Sodium dried, lbij.; Sulphuric Acid, ℥xx.; Distilled Water, f℥xxiv. The *Edinburgh College* employs equal weights of Purified Salt, Pure Sulphuric Acid, and Water. The *Dublin College* orders of Dried Muriate of Soda, 100 parts; Sulphuric Acid of commerce, 87 parts; and Water, 124 parts. The Chloride of Sodium is to be introduced into a glass retort, and the Sulphuric Acid mixed with part [f℥xij. *L.*; one-third, *E.*; one-half, *D.*] of the Water [and allowed to cool, *E.*] is then poured over the Salt; the remainder of the Water being placed in the receiver. Distillation is then to be effected, [by a sand-bath, *L.*, or by a naked gas-flame, *E.*] so that the gas may pass over into the water contained in the receiver, [which is to be kept cool by snow, or a stream of cold water, *E*]. The Acid thus procured is called, by the Edinburgh College, *Acidum muriaticum purum.*

The *theory* of the above process is precisely that already explained in the manufacture of hydrochloric acid gas (p. 275). The salt is dried, to expel any water which may be mechanically lodged between the plates of the crystal, and to obtain uniform weights.

The quantity of strong sulphuric acid ($\dddot{S} + \dot{H}$) required to saturate 2 lbs. of common salt is $19\frac{6}{10}$ oz.; so that the London College employs a slight excess only; whereas the Edinburgh College directs a much greater excess.

A pure muriatic acid is obtained in the manufacture of the liquid called *spirit of tin*. Tin is dissolved in commercial muriatic acid, and the solution submitted to heat in green glass retorts: pure muriatic acid distils over, and the residue in the retort constitutes spirit of tin.

PROPERTIES.—Pure liquid hydrochloric acid (*acidum hydrochloricum purum*) is colourless, evolves acid fumes in the air, and possesses the usual characteristics of a strong acid. It has the odour and taste of the gaseous acid. Its specific gravity varies with its degree of concentration. The London College fixes it at 1·16,—the Edinburgh College at 1·170. It is decomposed by some metals (*e. g.* zinc and iron), hydrogen being evolved, and a metallic chloride formed. It reacts on those oxyacids which contain five equivalents of oxygen each (*e. g.* nitric, chloric, iodic, and bromic acids): the oxygen of these acids unites with the hydrogen of the hydrochloric acid to form water. When it acts on a metallic oxide, water and a metallic chloride are produced.

Characteristics.—Hydrochloric acid yields, with nitrate of silver, a white, clotty, fusible precipitate (*chloride of silver*), which is insoluble in nitric acid, soluble in ammonia, and blackens by exposure to light[e]. When pure, it is without action on gold leaf, and does not decolorise sulphate of indigo. A rod dipped in a solution of caustic ammonia produces white fumes (*sal ammoniac*) when brought near strong liquid hydrochloric acid.

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[e] See p. 226.

Composition.—Liquid hydrochloric acid is composed of *water*, holding in solution *hydrochloric acid gas*. When its sp. gr. is 1·162, its composition, according to Dr. Thomson [f], is as follows:—

	Atoms.	*Eq. Wt.*	*Thomson.*
Hydrochloric acid gas	1	37	33·95
Water	8	72	66·05
Liquid hydrochloric acid, sp. gr. 1·162,	1	109	100·00

In the London Pharmacopœia it is stated that one hundred and thirty-two grains of crystallised carbonate of soda, saturate 100 grains of acid, sp. gr. 1·16. This would indicate a per-centage strength of 33·916.

Dr. Thomson's Table, exhibiting the Specific Gravity of Hydrochloric Acid of determinate Strengths.

Atoms of Water to one of Acid.	*Real Acid in 100 of the Liquid.*	*Specific gravity.*
6	40·659	1·203
7	37·000	1·179
8	33·945	1·162
9	31·346	1·149
10	29.134	1·139
11	27·206	1·1285
12	25·517	1·1197
13	24·026	1·1127
14	22·700	1·1060
15	21·512	1·1008
16	20·442	1·0960
17	19·474	1·0902
18	18·590	1·0860
19	17·790	1·0820
20	17·051	1.0780

Purity.—*Pure hydrochloric acid* (*acidum hydrochloricum purum*) is colourless, or nearly so, without action on gold leaf, and, when diluted with distilled water, is not altered by a solution of chloride of barium. *Commercial hydrochloric acid* (*acidum hydrochloricum venale*) is yellow, and contains usually sesquichloride of iron and sulphuric acid; and sometimes chlorine, nitrous acid (or some other oxide of nitrogen), and perhaps bromine. The Edinburgh College fixes its density at 1·180.

The presence of *iron* is shown by saturating the acid with carbonate of soda, and then applying tincture of nutgalls, which produces a black tint. Another mode is to supersaturate the liquid with ammonia or its sesquicarbonate, by which the red or sesquioxide of iron will be precipitated.

If the liquid acid contain either *free chlorine* (or *bromine*) it will possess the power of dissolving leaf-gold, or even of decolorising a small quantity of sulphate of indigo. A solution of protochloride of tin is the readiest test for detecting any gold, which may be dissolved, with which it forms a purplish or blackish precipitate.

Sulphuric acid (free or combined) may be detected by adding to the suspected acid a solution of chloride of barium (or nitrate of baryta): if sulphuric acid be present, a heavy white precipitate of sulphate of baryta is procured, which is insoluble in nitric acid. In applying this test, the suspected acid should be previously diluted with five or six times its volume of water; otherwise a fallacy may arise from the crystallization of the chloride of barium.

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[f] *An Attempt to establish the First Principles of Chemistry*, vol. i. p. 87. Lond. 1825.

Nitrous acid (or some other oxide of nitrogen) is recognisable by protosulphate of iron (see Nitric Acid).

PHYSIOLOGICAL EFFECTS.—α. *On Dead Animal Matter.*—Very dilute hydrochloric acid, mixed with dried mucous membrane, has the property of dissolving various animal substances (as coagulated albumen, fibrin of the blood, boiled meat, &c.), and of effecting a kind of artificial digestion of them, somewhat analogous to the natural digestive process[g].

β. *On Animals.*—The effects of liquid hydrochloric acid on living animals (horses and dogs) have been investigated by Sproegel, Courton, Viborg[h], and by Orfila[i]. Thrown into the veins it coagulates the blood, and causes speedy death. Small quantities, however, may be injected without giving rise to fatal results. Thus Viborg found that a horse recovered in three hours from the effects of a drachm of the acid diluted with two ounces of water, thrown into a vein. Administered by the stomach to dogs, the undiluted acid acts as a powerful caustic poison. Exhalations of the acid vapours take place through the mouth and nostrils, and death is generally preceded by violent convulsions.

γ. *On Man.*—Properly diluted, and administered *in small but repeated doses*, hydrochloric acid produces the usual effects of a mineral acid before described (pp. 189, 193, 201, and 212): hence it is tonic, refrigerant, and diuretic. It usually causes a sensation of warmth in the stomach, relaxes the bowels, and increases the frequency of the pulse. *Larger doses* are said to have excited giddiness and a slight degree of intoxication or stupor. In a *concentrated form* it operates as a powerfully caustic poison. The only recorded cases of poisoning by it (in the human subject) with which I am acquainted, are one mentioned by Orfila[j] and another related by my friend and former pupil, Mr. John Quekett[k]. In the latter case the stomach and duodenum were found, after death, to be charred, and the gall-bladder was observed to have a green tint at the part where it was in contact with the stomach [from the action of the acid on the bile?]. It is remarkable that the contents of the stomach manifested no acidity to litmus; nor could any chloride be recognized by nitrate of silver, either in the decoction of the stomach and duodenum, or in the contents of the stomach. The particular nature of the chemical changes effected by it in the organic tissues with which it comes in contact, is not so well understood as in the case of sulphuric or nitric acid. Its chemical action is less energetic than either of the acids just mentioned.

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[g] Müller, *Elements of Physiology*, p. 544.

[h] Wibmer, *Die Wirkung der Arzneimittel und Gifte.*

[i] *Toxicologie Générale.*

[j] *Toxicolog. Générale.*

[k] *London Medical Gazette*, vol. xxv. p. 285 [November 15, 1839].

USES. *a. Internal* or *Remote.*—Hydrochloric acid has been employed in those diseases formerly supposed to be connected with a putrescent condition of the fluids; as the so-called putrid and petechial fevers, malignant scarlatina, and ulcerated sore throat. It is usually administered, in these cases, in conjunction with the vegetable tonics; as cinchona or quassia. We frequently employ it to counteract phosphatic deposits in the urine. After a copious evacuation, it is, according to Dr. Paris, the most efficacious remedy for preventing the generation of worms; for which purpose the infusion of quassia, stronger than that of the Pharmacopœia, is the best vehicle. It has been employed with benefit in some forms of dyspepsia. Two facts give a remarkable interest to the employment of this acid in dyspeptic complaints; namely, that it is a constituent of the healthy gastric juice; and, secondly, when mixed with mucus, it has a solvent or digestive power in the case of various articles of food, as before mentioned. Lastly, hydrochloric acid has been used in scrofulous and venereal affections[l], in hepatic disorders, &c.

β. External.—In the concentrated form it is employed as a caustic to destroy warts, and as an application in sloughing phagedæna, though for the latter purpose it is inferior to nitric acid. Van Swieten[m] employed it in cancrum oris; and, more recently, Bretonneau[n] has spoken in the highest terms of its efficacy in angina membranacea, commonly termed diphtheritis. It is applied to the throat by a sponge. Properly diluted it forms a serviceable gargle in ulceration of the mouth and throat. The objection to its use as a gargle is its powerful action on the teeth: to obviate this as much as possible, the mouth is to be carefully rinsed each time after using the gargle. It is sometimes applied to ulcers of the throat by means of a sponge. Water acidulated with this acid has been applied to frost-bitten parts, to chilblains, &c. An injection composed of from eight to twelve drops of the acid to three or four ounces of water, has been employed as an injection in gonorrhœa. In those forms of dyspepsia accompanied with or dependent on a deficiency of this acid in the gastric juice, it is calculated to prove serviceable.

ADMINISTRATION.—It is given, properly diluted, in doses of from five to fifteen or twenty minims.

ANTIDOTES.—In a case of poisoning by hydrochloric acid, the antidotes are chalk, whiting, magnesia or its carbonate, and soap; and in the absence of these, oil, the bicarbonated alkalis, milk, white of egg, or demulcents of any kind. Of course the gastro-enteritis is to be combated in the usual way.

ACIDUM HYDROCHLORICUM DILUTUM, L.; *Acidum Muriaticum dilutum*, E. (Hydrochloric Acid, f℥iv.; Distilled Water, f℥xij. "The density of this preparation is 1·050," *E.*) The dose is from ʒss. to ʒj. The most agreeable mode of exhibiting it is in the infusion of roses, substituting the hydrochloric for sulphuric acid.

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[l] *Lond. Medical Review*, vol. ii. p. 278. Lond. 1800.

[m] *Commentaries*, Eng. Transl. vol. iv. p. 31. Edinb. 1776.

[n] *Recherches sur l'Inflammation spéciale du tissu muqueux, et en particulier sur la diphthérite, angine maligne, ou croup épidémique.* Paris, 1826.

4. AC'IDUM HYDRIOD'ICUM.—HYDRIODIC ACID.

Dr. Buchanan[o] has employed a solution of this acid in water. His formula for making it is as follows:—Dissolve 330 grs. of Iodide of Potassium in ℥iss. of Distilled Water, and to this add 264 grs. of Tartaric Acid also dissolved in ℥iss. of Distilled Water. When the Bitartrate of Potash has subsided, strain; and to the strained liquor add sufficient water to make fifty drachms (= ℥vj. ʒij.)—This solution, according to Dr. Buchanan, possesses all the therapeutical powers of iodine, without its irritant properties. He has given as much as ℥j. of it three times a day, or ʒij. of iodine daily. He regards ℥ss. as the ordinary dose; but it would be much safer to begin with a smaller dose.

ORDER VI.—NITROGEN, AND ITS COMPOUNDS WITH OXYGEN AND HYDROGEN.

1. NITROGEN'IUM. — NITROGEN.

History and Synonymes.—This gas was first recognised in 1772, by Dr. Rutherford, who termed it *mephitic air*. Priestley called it *phlogisticated air*. Lavoisier named it *azote* (from α privitive; and ζωὴ, *life*). Cavendish, finding it to be a constituent of nitric acid, gave it the appellation it now usually bears, *nitrogen* (from νίτρον, *nitre*; and γεννάω, *I beget*).

Natural History.—It is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—It has not hitherto been found in non-fossiliferous rocks. It is a constituent of coal, of nitrates, of ammoniacal salts, and of some mineral waters. It forms 79 or 80 per cent. of the atmosphere.

β. In the Organised Kingdom.—It is a constituent of various vegetable principles, as the organic alkalis, gluten, and indigo blue; and is particularly abundant in the families *Cruciferæ* and *Fungi*. It enters into the composition of most animal substances, as albumen, fibrin, gelatine, mucus, urea, uric acid, &c. It is found in the swimming bladders of fishes.

Preparation.—The readiest method of procuring nitrogen is to burn a piece of phosphorus in a confined portion of atmospheric air. The phosphorus combines with the oxygen of the air and forms metaphosphoric acid. The residual gas, after being thoroughly washed, is nearly pure nitrogen.

Properties.—It is a colourless, odourless, tasteless gas; neither combustible nor a supporter of combustion. It neither reddens litmus, nor whitens lime water. Its sp. gr. is 0·9722 [0·976 Berzelius]. It is very slightly absorbed by water. Its equivalent by weight is 14 [14·19 Berzelius; 14·15 Turner], by volume 1.

1 eq.
Nitrogen
= 14

Characteristics.—Nitrogen is usually distinguished by its negative properties just described. The only positive test for it is combining it with oxygen to form nitric acid. This may be effected in two ways; either by electrifying a mixture of nitrogen and oxygen, or by burning a stream of hydrogen in a mixture of oxygen and nitrogen. The nitric acid thus produced reddens litmus, and when absorbed by potash may be recognised by the tests hereafter to be mentioned. (See *Nitric Acid.*)

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[o] *London Medical Gazette*, vol. xviii. p. 517.

Physiological Effects.—The effects of nitrogen gas on vegetables and animals are analogous to those of hydrogen before mentioned[p]. Thus, when inspired, it acts as an asphyxiating agent, by excluding oxygen; when injected into the blood it acts mechanically only. It is an essential constituent of the air employed in respiration.

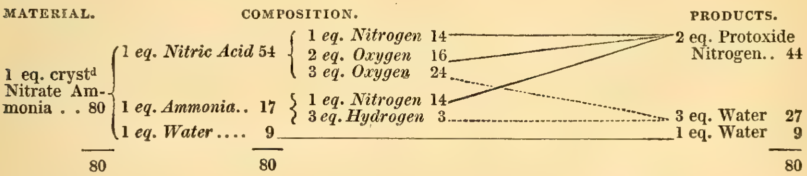
Uses.—It has been mixed with atmospheric air, and inspired in certain pulmonary affections, with the view of diminishing the stimulant influence of the oxygen, and thereby of acting as a sedative.

2. NITROGEN'II PROTOX'YDUM.—PROTOXIDE OF NITROGEN.

History and Synonymes.—This gas was discovered by Dr. Priestley in 1776. He termed it *dephlogisticated nitrous air.* Sir H. Davy[q] called it *nitrous oxide.* Its common name is *laughing gas.*

Natural History.—This compound is always an artificial production.

Preparation.—It is obtained by heating nitrate of ammonia in a glass retort. Every equivalent or 80 parts of the crystallised salt are resolved into four equivalents or 36 parts of water, and two equivalents or 44 parts of protoxide.



Properties.—At ordinary temperatures and pressure it is a colourless gas, with a faint not disagreeable odour, and a sweetish taste. It is not combustible, but is a powerful supporter of combustion, almost rivalling in this respect oxygen gas. Protoxide of nitrogen does not affect vegetable colours. It undergoes no change of colour or of volume when mixed with either oxygen or the binoxide of nitrogen.

1 eq.
Protoxide
Nitrogen
= 22

Its equivalent, by weight, is 22 [22·2 Berzelius], by volume 1. Its sp. gr., according to Dr. T. Thomson, is 1·5277. When subjected to a pressure of 50 atmospheres, at 45° F., it is condensed into a limpid colourless liquid.

Characteristics.—The only gas with which it is possible to confound it, is oxygen, with which it agrees in being colourless, not combustible, but a powerful supporter of combustion, re-inflaming a glowing match. From this it may be readily distinguished by mixing it with an equal volume of hydrogen, and exploding it by the electric spark, by which we obtain one volume or 14 parts of nitrogen, and an equivalent or 9 parts of water. If a taper be burnt in a jar of this gas over water, a brown vapour (*nitrous acid gas*) is produced.

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[p] See p. 126.

[q] *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and its Respiration.* 1800.

Before combustion.		*After combustion.*	
1 eq. Protox. Nitr. = 22	1 eq. Hydrog. = 1	1 eq. Nitrogen = 14	and 1 eq. Water = 9

Composition.—It consists of one equivalent or 14 parts of nitrogen, and one equivalent or 8 parts of oxygen; or, by measure, a volume of nitrogen and half a volume of oxygen condensed into the space of one volume.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Davy.*
Nitrogen	1	14	63·6	63·3
Oxygen	1	8	36·4	36·7
Protoxide Nitrogen	1	22	100·0	100·0

	Vol.	*Sp. gr.*
Nitrogen gas	1	0·9722
Oxygen gas	0·5	0·5555
Protox. Nitrogen gas	1	1·5277

Physiological Effects. *a.* *On Vegetables.*—Germinating seeds (peas), when watered with a solution of this gas, seemed unaffected by it. Plants introduced into vessels filled with the gas mostly faded in about three days, and died shortly after[r]. But Drs. Turner and Christison did not find that it was injurious to vegetation[s].

β. *On Animals.*—The effects of this gas on insects, annelides, mollusca, amphibials, birds, and mammals, were examined by Sir H. Davy. On all it acted as a positive poison. It produced "peculiar changes in their blood and in their organs, first connected with increased living action; but terminating in death[t]." Slowly injected into the veins of animals, considerable quantities were found by Nysten to produce slight staggering only; larger quantities produced the same disorder of the nervous system noticed when the gas is respired[u].

γ. *On Man.*—When inhaled, its effects on the nervous system are most remarkable: I have administered this gas to about one hundred persons, and have observed that after the respiration of it from a bladder for a few seconds, it usually causes frequent and deep inspirations, blueness of the lips and countenance, an indisposition to part with the inhaling tube, and a temporary delirium, which subsides in the course of three or four minutes. The sensations are usually pleasing. The delirium manifests itself differently in different individuals; as in some by dancing, in others by fighting, &c. In some few cases I have seen stupor produced. Singing in the ears, giddiness, and tingling sensations in the hands and feet, are sometimes experienced.

Uses.—It has been employed in some few cases only of disease. Beddoes used it in paralysis with benefit, but found it injurious to the hysterical and exquisitely sensible[v]. In a remarkable case of spasmodic asthma, related by Mr. Curtis[w], it acted beneficially. In a second case it also gave relief.

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[r] Davy's *Researches.*

[s] Christison, *On Poisons*, p. 756.

[t] Davy, p. 449.

[u] *Recherches*, pp. 77 & 78.

AQUA NITROGENII PROTOXYDI; *Protoxide of Nitrogen Water; Searle's Patent Oxygenous Aërated Water.*—At ordinary temperatures and pressures, water dissolves about three-fourths of its own bulk of protoxide of nitrogen; but by pressure the quantity may of course be augmented. The patent solution is said to contain five times its bulk of gas; or each bottle of the liquid is stated to hold a full quart of gas. Its effects on the system are not very marked. Sir H. Davy drank nearly three pints of the ordinary solution in one day, and says that it appeared to act as a diuretic; and he adds, "I imagined that it expedited digestion" (*Op. cit.* p. 237). The proprietor of the patent water asserts that it exhilarates, and is adapted for torpor, depression of spirits, asthma, &c.

3. AC′IDUM NI′TRICUM, *L. E. D.*—NITRIC ACID.

History and Synonymes.—This acid was known in the seventh century to Geber, who termed it *solutive water*[x]. The nature of its constituents was shewn by Cavendish in 1785, and their proportions were subsequently determined by Davy, Gay-Lussac, and Thomson. It has been known by various names, as *Glauber's spirit of nitre*, and *aquafortis*.

Natural History.—It is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—Combined with potash, soda, lime, or magnesia, it is found on the surface of the earth in various parts of the world. The nitrates have been found in some few mineral waters. Thus there is a district of Hungary, between the Carpathians and the Drave, where all the springs, for the space of about 300 miles, contain a small quantity of the nitrate of potash[y].

β. In the Organised Kingdom.—Nitrate of lime has been found in *Borago officinalis*, *Urtica dioica*, *Helianthus annuus*, and *Parietaria officinalis*. Nitrate of potash has been detected in the roots of *Cissampelos Pareira*, and *Geum urbanum*; in the juice of *Chelidonium majus*; in *Apium graveolens*; and sometimes in the root of *Beta vulgaris* when advanced in age. The same salt is also found in the flowers of *Verbascum*, in the rhizome of *Zingiber officinale*, in the fruit of *Areca Catechu*, in the tubercle of *Cyperus esculentus*, in *Agaricus acris*, and *A. edulis*[z].

Preparation.—Nitric acid is prepared by submitting a mixture of Oil of Vitriol and Nitrate of either Soda or Potash to distillation.

The apparatus used on the large scale is usually that employed in the manufacture of hydrochloric acid[a]; namely, an iron or stoneware pot, with a stoneware head, which is connected with a row of double-necked stoneware bottles containing water. Another form of apparatus employed by some manufacturers, is an iron cylinder, set in brickwork over a fire-place (fig. 51). 168lbs. of nitrate of potash are introduced at one end of the cylinder, which is afterwards closed by a circular disk of iron perforated to allow of the introduction of

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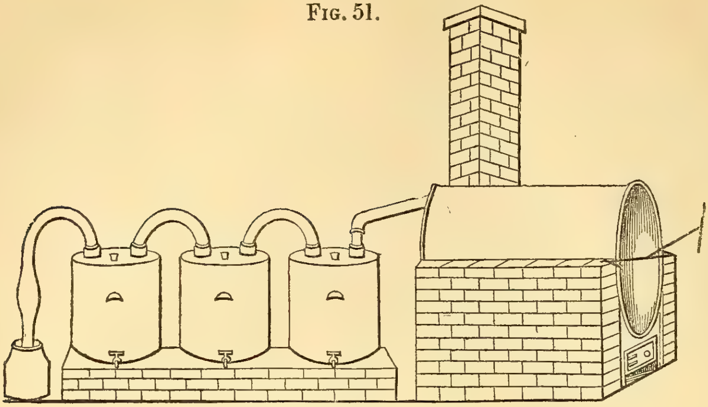
[v] Davy's *Researches*, p. 542.
[w] *Lancet*, vol. ii. for 1828 & 1829.
[x] *Of the Invention of Verity*, ch. xxi. and xxiii.
[y] Gairdner, *On Mineral Springs*, p. 20.
[z] See fig. 50, p. 277.
[a] De Candolle, *Physiol. Végét.* t. 1er, pp. 383, 387, and 403.

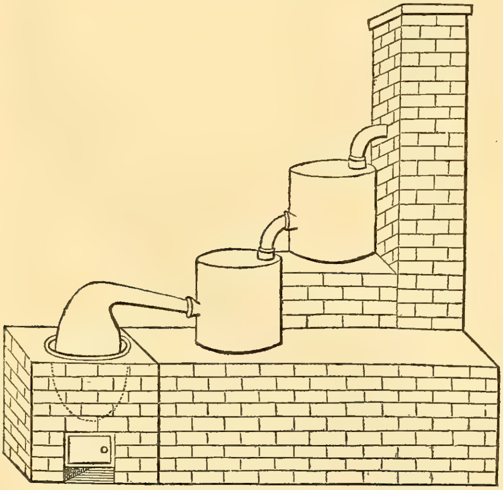
FIG. 51.



Nitric Acid Apparatus.

a leaden flunnel, through which are poured 93 lbs. of strong sulphuric acid (sp. gr. 1·845). The funnel is then removed, the aperture closed, and heat applied. The vapours are conveyed into a row of five or six bottles of stone-ware filled to about one-sixth of their capacity with water. The acid obtained by this process is brown and fuming, and has a sp. gr. of 1·45. It is called in commerce *nitrous acid*, or *fuming nitric acid* (*acidum nitrosum; acidum nitroso-nitricum; acidum nitricum fumans*). To render it colourless it is heated in a glass retort, placed in a sand bath: the vapour which escapes is passed through two stone-ware bottles to save any acid that may be expelled, and is subsequently conveyed into a chimney (fig. 52). The colourless acid remaining in the retort has a sp. gr. of from 1·38 to about 1·4, and constitutes the *nitric acid of commerce* (*acidum nitricum venale*). The residue in the iron cylinder is a mixture of sulphate with a little bisulphate of potash, and is sold as *sal enixum.* It is employed as a flux, and in the manufacture of alum[b].

FIG. 52.



Apparatus for the purification of coloured nitric acid.

The quantity of the ingredients employed in the above process is nearly in the proportion of eight equivalents or 392 parts of strong sulphuric acid, and seven equivalents or 714 parts of nitrate of potash.—Some manufacturers employ two parts by weight of nitrate of potash and one of strong sulphuric acid, or about an equivalent of each of the ingredients. As the water of the sulphuric acid is not sufficient in quantity to form liquid nitric acid with all the acid set free from the nitrate, a part of the nitric acid is decomposed into nitrous acid and oxygen. It is the presence of nitrous acid which communicates the red colour to the commercial or fuming nitric acid.

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[b] For the above information I am indebted to Messrs. White, nitric acid manufacturers, Castle-Street, Saffron Hill, London, who have kindly permitted me to make the above sketches of their apparatus.

I am informed by a manufacturer who employs nitrate of soda in the production of nitric acid, that he obtains about as much by weight of nitric acid, sp. gr. 1·4, as of nitrate of soda consumed.

All the British Pharmacopœias give formulæ for the preparation of nitric acid. The *London* and *Edinburgh Colleges* use equal weights of dried Nitrate of Potash and Sulphuric Acid. The *Dublin College* directs 100 parts of Nitrate of Potash and 97 parts of commercial Sulphuric Acid. The distillation is to be conducted in a glass retort, by a sand heat. The directions of the Edinburgh College for obtaining pure nitric acid (*acidum nitricum purum*) are as follows:—

> "Purify Nitrate of Potash, if necessary, by two or more crystallizations, till Nitrate of Silver does not act on its solution in distilled water. Put into a glass retort equal weights of this purified nitrate and of sulphuric acid, and distil into a cool receiver, with a moderate heat from a sand-bath or naked gas-flame, so long as the fused material continues to give off vapour. The pale-yellow acid thus obtained may be rendered colourless, should this be thought necessary, by heating it gently in a retort."

Mr. Phillips states, that the acid obtained by the process of the London Pharmacopœia has a specific gravity of 1·5033 to 1·504. The Edinburgh College fixes the density of the pure acid at 1·500; and that of the commercial acid at 1·380 at least.

The explanation of the changes which take place is somewhat modified by the strength of the sulphuric acid employed. According to Mr. Phillips, the acid usually met with has a sp. gr. of 1·8433; I have found it generally somewhat below this. The acid alluded to by Mr. Phillips is composed, according to the same authority, very nearly of four equivalents or 160 parts of dry sulphuric acid, and five equivalents or 45 parts of water. These quantities react on two equivalents or 204 parts of nitrate of potash, and produce two equivalents or 135 parts of strong liquid nitric acid (sesquihydrate), and one equivalent or 274 parts of the hydrated bisulphate of potash.

MATERIALS.		COMPOSITION.		PRODUCTS.	
2 eq. Nitrate Potash .	204	2 *eq. Nitric Acid* .	108	2 Sesquihydrate Nitric Acid	135
		2 *eq. Potash* . . .	96		
4 eq. Liquid Sulph. Acid (Sp. gr. 1·8433)	205	3 *eq. Water* . . .	27		
		2 *eq. Water* . . .	18		
		4 *eq. Sulph. Acid*	160	2 Hyd. Bisulphate Potash	274
	409		409		409

The generation of nitrous acid is greatest at the commencement and towards the close of the operation: for, at the commencement, the excess of uncombined sulphuric acid attracts water from the small quantity of nitric acid then set free, in consequence of which the latter is resolved into nitrous acid and oxygen: about the middle of the process, when the quantity of free nitric acid has increased, while that of sulphuric acid has diminished, the former passes over with water unchanged; but towards the end of the process, owing to the volatilization of the nitric acid, the sulphuric acid becomes again predominant, and the red vapours of nitrous acid then make their appearance.

PROPERTIES.—Strong and pure liquid nitric acid (*acidum nitricum purum*) is colourless, and has a peculiar odour, and an acrid, intensely sour taste. In the air it evolves white fumes, formed by the union of the acid vapour with the aqueous vapour of the atmosphere; these fumes redden litmus, and become much whiter when mixed with the vapour of ammonia, owing to the formation of the nitrate of ammonia. The sp. gr. of the acid, prepared according to the Pharmacopœia, is 1·5033 to 1.504, and Mr. Phillips believes this to be the strongest procurable; but Proust says he obtained it as high as 1·62; Kirwan, 1·554; Davy, 1·55; Gay-Lussac, 1·510: Thenard, 1·513. The Edinburgh College fixes the density of pure nitric acid at 1·500. The acid sold in the shops as *double aquafortis* (*aqua fortis duplex*) has a sp. gr. of 1·36. *Single aquafortis* (*aqua fortis simplex*) is of sp. gr. 1·22. Nitric acid has a powerful affinity for water; and, when mixed with it, heat is evolved.

Nitric acid is easily deprived of part of its oxygen. Thus, exposure to solar light causes the evolution of oxygen, and the production of nitrous acid, which gives the liquid a yellow, orange, or reddish-brown colour. The acid, thus coloured, may be rendered colourless by the application of a gentle heat, to drive off the nitrous acid. Several of the non-metallic combustibles rapidly decompose nitric acid; ascharcoal, phosphorus, sugar, alcohol, volatile oils, resins, &c. The acid is unacted on by leaf-gold, platinum, &c. Some of the metals[c] also act powerfully on it, as copper (in the form of turnings), and tin (in the state of foil). A little water added to the acid facilitates, in some cases, the action of metals on it. The hydracids (as hydrochloric acid) decompose and are decomposed by nitric acid.

Characteristics.—Nitric acid is known by the following characters:—It stains the cuticle yellow or orange: mixed with copper filings, effervescence takes place, owing to the escape of binoxide of nitrogen, and a greenish-blue solution of nitrate of copper is obtained: the binoxide forms ruddy vapours in the air, by uniting with oxygen to form nitrous acid gas; and, passed into a solution of the protosulphate of iron, forms a dark olive-brown coloured liquid, which has a strong affinity for oxygen, and has in consequence been employed for analysing atmospheric air: but the results obtained by it are uncertain. Nitric acid decolorises sulphate of indigo. Morphia, brucia, or commercial strychnia, communicates a red colour to nitric acid, which is heightened by supersaturating the liquor with ammonia: powdered nux vomica renders this acid yellow or orange-coloured. If hydrochloric acid be added to nitric acid, the mixture acquires the power of dissolving leaf-gold: the presence of gold in solution may be recognised by the protochloride of tin, with which it strikes a purple or blackish colour. Lastly, saturated with pure carbonate (or bicarbonate) of potash, a nitrate of potash is procured.

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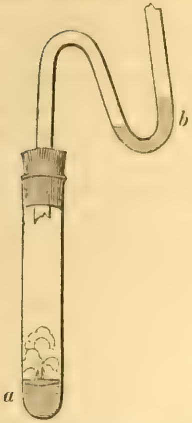
[c] For an account of the anomalous relations of this acid and iron, I must refer the reader to Becquerel's *Traité de l'Electricité*, tom. v. p. 8.

The *nitrates* are known by the following characters:—they evolve oxygen when heated, and deflagrate when thrown on a red-hot cinder or charcoal; when heated with sulphuric acid they disengage nitric acid, which may be recognised by its action on morphia, brucia, or commercial strychnia; lastly, when mixed with sulphuric acid and copper turnings, they generate binoxide of nitrogen, which is readily recognised by its blackening a solution of sulphate of the protoxide of iron. This last-mentioned property enables us to recognise very minute portions of the nitrates. The nitrate, copper filings, and sulphuric acid, are to be put into the test-tube (fig. 53, *a*): to which is adapted, by means of a cork, a small curved glass tube, containing at the bend (*b*) a drop or two of the solution of the protosulphate of iron; heat is to be applied to the mixture in the test-tube, and in a few minutes the ferruginous solution becomes brown or blackish.

FIG. 53.

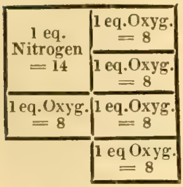


COMPOSITION.—*Anhydrous* or *dry nitric acid*, such as we find it in some nitrates, has the following composition by weight:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Lavoisier.*	*Cavendish.*	*Berzelius.*	*Davy.*
Nitrogen	1	14	25·9	20	25	26	29·5
Oxygen	5	40	74·1	80	75	74	70·5
Nitric Acid	6	54	100·0	100	100	100	100

According to Berzelius, its equivalent is 54·25 [54·15, Turner].

Its composition by volume, is, one volume of nitrogen gas and two and a half volumes of oxygen gas. The degree of condensation, however, is not known, as uncombined anhydrous nitric acid has not yet been procured.



Liquid nitric acid is composed of nitric acid and water. According to Mr. Phillips, when the specific gravity of the liquid is 1·5033 to 1·504, the composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Dry or Anhydrous Nitric Acid	1	54	80
Water	1½	13·5	20
Sesquihydrate of Nitric Acid	1	67·5	100

100 grains of this acid will saturate about 217 grains of carbonate of soda, equal to about 81 grains of real or dry nitric acid.

IMPURITIES.—The presence of nitrous acid is known by the colour. To detect chlorine or the chlorides, dilute with distilled water, and apply nitrate of silver; a white chloride of silver is precipitated, which is insoluble in nitric acid, but soluble in ammonia. To recognise sulphuric acid, add a solution of chloride of barium to the diluted acid; a heavy white sulphate, insoluble in nitric acid, is thrown down. Any fixed impurities may be obtained by evaporation.

Physiological Effects. *α. On Vegetables.*—Nitric acid decomposes the different vegetable tissues to which it may be applied, and gives them a yellow colour.

β. On Animals.—Orfila found that 26 grains of commercial nitric acid, injected into the jugular vein, coagulated the blood, and caused death in two minutes[d]. Viborg threw a drachm of the acid, diluted with three drachms of water, into the jugular vein of two horses; in two hours they were well: the blood, when drawn, was slightly coagulated[e]. Introduced into the stomach of dogs, it disorganises this viscus, and causes death in a few hours.

γ. On Man.—On the *dead body*, M. Tartra has made various experiments to determine the appearances produced by the action of nitric acid. Of course this caustic decomposes the organic textures; but the phenomena presented vary according to different circumstances,—as the quantity employed, the presence of other substances, &c.

On the *living body*, its action varies with the degree of concentration or dilution of the acid. In the concentrated form the acid acts as a powerfully corrosive poison, which property it derives in part from its affinity for water, but more especially from the facility with which it gives out oxygen; so that the appearances caused by its action on some of the tissues are different from those produced by sulphuric acid. Thus the permanent yellow stain which it communicates to the cuticle is peculiar to it. Iodine, indeed, stains the skin yellow or brown, but a little caustic potash readily removes the stain when recent; whereas the yellowish stain produced by nitric acid, becomes orange on the addition of an alkaline soap. Bromine also stains the skin yellow, but when recently produced, the colour may also be removed by potash. The yellow or citron stain communicated to the lining membrane of the tongue, pharynx, &c. by nitric acid, has been well shewn by Dr. Roupell[f]. A preparation, presenting similar appearances, is preserved in the anatomical museum of the London Hospital. The yellow substance produced by the action of nitric acid on fibrin, was termed by MM. Fourcroy and Vauquelin the *yellow acid:* the same substance is probably produced by the application of nitric acid to other animal principles. This yellow substance is bitter, and is said by Berzelius to consist of yellow, altered fibrin, combined with nitric acid and with malic acid, formed by the action of some nitric acid on the fibrin. Nitric, like sulphuric acid, also chars the animal tissues, and thus, after the ingestion of it, the stomach is sometimes found blackened, as if sulphuric acid had been swallowed. The symptoms are analogous to those produced by sulphuric acid (see *Sulphuric Acid*). The yellow, citron, or orange spots, sometimes observed on the lips, chin, or face, will, when present, at once indicate the kind of acid swallowed. Sometimes the binoxide of nitrogen is evolved by the mouth.

Properly diluted, nitric acid produces effects similar to those of the other dilute acids[g]. It is said, however, to act less evidently as a tonic, and to be more apt to disagree with the stomach, so that it cannot be employed for so long a period. In some cases it has excited ptyalism, and from this circumstance, as well as from the occasional benefit derived from its use in the venereal disease, it has by some writers been compared, in its operation, to mercury; a comparison founded rather on theoretical than practical considerations.

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[d] *Toxicolog. Générale.*
[e] Wibmer, *Die Wirkung*, &c.
[f] See his *Illustrations of the Effects of Poisons.*

USES.—α. *Internal.*—As nitric acid produces certain effects, in common with other mineral acids, it may be used as a substitute for the latter in various diseases. Thus, it is administered in conjunction with the bitter infusions, in those conditions admitting of, or requiring, the use of tonics. Properly diluted, it is employed as a refrigerant in febrile disorders. In lithiasis, attended with phosphatic deposits in the urine, it may be used instead of the sulphuric or hydrochloric acid. In some obstinate cutaneous diseases, as impetigo, it is given to the extent of half a drachm daily in barley water[h]. It may be employed also to relieve heartburn.

In 1793 this acid was used by Mr. Scott, a surgeon, at Bombay, as a substitute for mercurial preparations, which Girtanner erroneously fancied owed their efficacy to the quantity of oxygen which they contained. Mr. Scott first tried it in chronic hepatitis, and with considerable success. He then extended its use to venereal diseases, and obtained the happiest results from it.

Subsequently, it has been most extensively employed in the last-mentioned diseases; but the success attending its use has been very variable. That it has been, and is frequently serviceable, no one can doubt who reads the immense body of evidence offered in its favour by Scott, Kellie, Albers, Prioleau, Rollo, Cruickshank, Beddoes[i], Ferriar, and others. But on the other hand it is equally certain that on very many occasions it has been useless. The same remark, indeed, may be made of mercury, or of any other remedy: but as an antivenereal medicine it does not admit of comparison with this metal. However, we frequently meet with syphilitic cases in which the employment of mercury is either useless or hurtful. Thus it can rarely be employed with advantage in scrofulous subjects; or in persons whose idiosyncrasies render them peculiarly susceptible to the influence of this metal; and in sloughing sores it is inadmissible. Now these are the cases in which nitric acid may be employed with benefit; and I believe the best mode of administering it is in conjunction with the compound decoction of sarsaparilla.

For further information respecting its employment, I must refer to the works of Holst[j] and Mr. Samuel Cooper[k].

β. *External*[l].—In the *concentrated* state, nitric acid has been employed as a powerful caustic to destroy warts, and as an application to parts bitten by rabid animals or venomous serpents, to phagedenic ulcers, &c. In order to confine the acid to the spot intended to be acted on, the neighbouring parts may be previously smeared with some resinous ointment. In sloughing phagedæna the application of strong nitric acid, as recommended by Mr. Welbank[m], is attended with the most successful results, as I have on several occasions witnessed. The best mode of applying it is by a piece of lint tied round a small stick or skewer. When the slough is very thick, it is sometimes necessary to remove part of it with a pair of scissors, in order to enable the acid to come in contact with the living surface.

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[g] See pp. 180, 193, 201, and 212: also *Hydrochloric* and *Sulphuric Acids.*

[h] Rayer, *Treatise on the Diseases of the Skin*, p. 502.

[i] *Reports, principally concerning the Effects of the Nitrous Acid in Venereal Disease.* Bristol, 1797.

[j] *De Acidi Nitrici usu Medico Dissertatio.* Christianæ, 1818.

[k] *Dict. of Practical Surgery.*

[l] On the external use of nitric acid, see *London Medical Repository*, vol. xiv. p. 450. 1820.

Largely *diluted* (as 50 or 60 drops of strong acid to a pint or quart of water) it is recommended by Sir Astley Cooper as a wash for sloughing and other ill-conditioned sores.

In the form of *ointment* it is used in various skin diseases, especially porrigo and scabies, and as an application to syphilitic sores.

Nitric acid vapour has been employed to destroy contagion, but it is probably inferior to chlorine. It was first introduced for this purpose by Dr. Carmichael Smyth[n] (to whom Parliament granted a reward of £5000): hence these fumigations have been termed *Fumigationes nitricæ Smythianæ.* The vapour is readily developed by pouring one part of oil of vitriol over one part of nitrate of potash in a saucer placed on heated sand.

ADMINISTRATION. — *Strong nitric acid* may be administered, in some mild diluent, in doses of from five to ten minims, three or four times daily.

ANTIDOTES.—Poisoning by nitric acid requires precisely the same treatment as that by sulphuric acid. (See *Sulphuric Acid.*)

1. **ACIDUM NITRICUM DILUTUM,** L. E. D. *Diluted Nitric Acid;* (Nitric Acid, f℥j.; Distilled Water, f℥ix. *L.*—"Mix together three fluid ounces of Nitric Acid (commercial) and four fluid ounces of Water. If Pure Nitric Acid be used, four fluid ounces of it must be mixed with six fluid ounces of Water. The density of this preparation is 1.290." *E.*[nn]—Nitric Acid, by measure, 3 parts; Distilled Water, by measure, 4 parts. *D.*) The sp. gr. of the diluted nitric acid of the London Pharmacopœia is 1·080; 100 grains of it saturate about 31 grains of crystallised carbonate of soda. The following is its composition:—

Dry or Anhydrous Nitric Acid..	11·44	Strong liquid Nitric Acid (sesquihydrate)	14·3
Water..	88·56	Water	85·7
Diluted Nitric Acid, Ph. L.	100·00		100·0

The dose of this preparation is from thirty to forty minims.

2. **UNGUENTUM ACIDI NITRICI,** D. *Oxygenised Fat; Pommade d'Alyon.*—(Olive Oil, ℔j.; Prepared Hog's-lard, ℥iv.; Nitric Acid,

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[m] *Medico-Chirurg. Trans.* vol. xi.

[n] *The Effects of the Nitrous Vapour in preventing and destroying Contagion*: Lond. 1799. Reviewed in the *London Medical Review*, vol. i. p. 433. Lond. 1799.

[nn] Diluted nitric acid, Ph. Ed., prepared with pure nitric acid (sp. gr. 1·5), has a sp. gr. 1·292, and contains 39·72 per cent. of real acid. But if prepared with commercial nitric acid (sp. gr. 1·381), its sp. gr. is 1·11897, and it contains 26·40 per cent. of real acid. So that the strengths of these varieties of dilute nitric acid are to each other, by weight, as 100 to 66—by measure, as 100 to 60; a difference of 40 per cent. in acids prepared by the two modes directed.—(Mr. R. Phillips, *London Med. Gaz.* May 8, 1840, p. 273.)

by measure, ʒvss. Having melted the oil and lard in a glass vessel, when they are beginning to become concrete add the acid: then stir them constantly with a glass rod until they become firm.) The nitric acid undergoes partial decomposition, binoxide of nitrogen being evolved. Part of the fatty matter is oxydized and converted into *Elaïdine* (see *Unguentum Hydrargyri Nitratis*). This ointment has a firm consistence and a yellow colour. Its uses have been above noticed. It is more efficacious when recently prepared.

4. AC'IDUM NI'TRO-HYDROCHLOR'ICUM.—NITRO-HYDROCHLORIC ACID.

(Acidum Nitro-muriaticum, *D.*)

History and Synonymes.—This liquid was known to Geber[o]. It was formerly called *aqua regia*. Its nature was first explained by Davy.

Preparation.—It is readily prepared, according to the Dublin Pharmacopœia, by mixing 2 parts, by measure, of hydrochloric acid with 1 part, by measure, of nitric acid.

In the arts, however, hydrochlorate of ammonia, or common salt, is often substituted for hydrochloric acid; or nitrate of potash for the nitric acid.

By the reaction of one equivalent or 54 parts of nitric acid on one equivalent or 37 parts of hydrochloric acid, we obtain one equivalent or 46 parts of nitrous acid, one equivalent or 36 parts of chlorine, and an equivalent or 9 parts of water.

MATERIALS.		COMPOSITION.		RESULTS.	
1 eq. Hydrochloric Acid	37	*1 eq. Chlorine* ..	36	1 eq. Chlorine .	36
		1 eq. Hydrogen .	1	1 eq. Water . .	9
1 eq. Nitric Acid . .	54	*1 eq. Oxygen* . .	8		
		1 eq. Nitrous Acid	46	1 eq. Nitrous Acid	46
	91		91		91

Properties.—It has a yellow colour. Its most remarkable property is that of dissolving gold and platinum, metals that are insoluble in either nitric or hydrochloric acid separately. It should be kept in a cool dark place, for heat rapidly expels the chlorine, while light enables it to decompose the water and to form hydrochloric acid.

Characteristics.—It is recognised by its colour, by its power of dissolving gold, by its precipitating a solution of the nitrate of silver, the precipitate being insoluble in nitric acid, but soluble in ammonia; by the production of two salts, a chloride and a nitrate, when an alkali is added to it; and by the evolution of binoxide of nitrogen on the addition of copper turnings (see *Nitric Acid.*)

Physiological Effects.—It is a powerfully corrosive poison, acting in a similar manner to nitric acid.

Uses.—It has been employed *internally* in the same cases as nitric acid, more especially syphilis, diseases of the liver, and some of the exanthemata. *Externally* it has been used as a bath, either local or general, in syphilis and hepatic affections. Dr. Lendrick[p] has more recently noticed the utility of the general nitro-muriatic bath, at a temperature of 90° or 95°, in syphiloid and mercurial cachexiæ, and liver consumption. In India the whole body (the head excepted) is immersed; but in this country pediluvia only are usually employed, or the body is merely sponged with it.

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[o] *Invention of Verity*, ch. xxiii.

Administration.—When taken internally the dose is ten or fifteen drops properly diluted, and carefully increased.

Antidote.—Poisoning by this acid is to be treated in the same way as that by sulphuric acid.

BALNEUM NITRO-HYDROCHLORICUM. — The nitro-muriatic bath[q] is prepared in wooden tubs, by adding this acid to water, until the latter becomes as acid to the taste as vinegar (from 4½ to 6 fluidounces of the acid to about 3 gallons of water in a deep narrow tub.) The patient should remain in the bath from 10 to 30 or 40 minutes. It excites tingling and prickling of the skin, and is said to affect the gums and salivary glands, causing plentiful ptyalism; indeed, we are told that, without the latter effect, every trial is to be regarded as inconclusive. In the passage of biliary calculi this bath is said to have proved remarkably effective.

5. AMMO'NIA.—AMMONIA OR AMMONIACAL GAS.

History and Synonymes.—It is probable that Pliny was acquainted with the smell of Ammonia, and that the "vehement odour" which he says[r] arose from mixing lime with nitrum was produced by the action of lime on sal ammoniac. Dr. Black, in 1756, first pointed out the distinction between ammonia and its carbonate; and Dr. Priestley[s] first procured ammonia in a gaseous form. He called it *alkaline air*. It is sometimes termed *volatile alkali*, and occasionally *azoturetted hydrogen*.

Natural History.—Ammonia, free or combined, exists in both kingdoms of nature.

α. In the Inorganised Kingdom.—Hydrochlorate and sulphate of ammonia are met with native usually in the neighbourhood of volcanoes. Aluminous sulphate of ammonia (or ammonia-alum) occurs in Bohemia. Dr. Marcet detected the hydrochlorate in sea water. This salt has also been recognised in mineral waters[t]. Ammonia exists in many of the native oxides of iron, and in some chalybeate waters. Carbonate of ammonia exists in rain water[u].

β. In the Organised Kingdom.—Ammonia is found in vegetables, in small quantities only. In the free state, it is said to exist in several plants, as *Chenopodium vulvaria*, *Sorbus aucuparia*[v], in the juice of the leaves of *Isatis tinctoria*, in the bark of *Zanthoxylum Clava Herculis*, and in *Fucus vesiculosus*. Combined with carbonic acid, it is found in *Justicia purpurea;* with nitric acid, in the extract of hyoscyamus, distilled water of the lettuce, &c. In combination with different substances, it is found in the root of *Helleborus niger*, and of *Nymphæa;* in the leaves of *Aconitum Napellus;* in the barks of *Cusparia febrifuga* and *Simaruba;* and in the fruit of *Areca Catechu*[w]. Lastly, it is developed during the decomposition (spontaneous or artificial) of most vegetable substances which contain nitrogen; as gluten.

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[p] *British and Foreign Medical Review*, vol. iv. p. 254.

[q] See Coyne's *Observations on the Aid obtained in various Diseases, particularly those incidental to Tropical Climates, by the external application of the Nitro-muriatic Acid in a Bath.* Lond. 1822.

[r] *Historia Naturalis*, lib. xxxi. cap. 46. Ed. Valp.

[s] *On Air*, vol. ii. p. 369, 1790.

[t] Gairdner, *On Mineral Springs*, p. 15.

[u] See p. 259.

[v] *Dict des Drogues*, t. i. p. 293.

Ammonia is one of the bases found in the urine of man, where it exists in combination with phosphoric, hydrochloric, and uric acids. United to the last-mentioned acid, it exists in the excrement of the Boa constrictor, and of some birds. The hydrochlorate is found in the dung of the camel. Ammonia is one of the products of the putrefaction of animal matters.

Preparation.—Ammoniacal gas is obtained by heating a mixture of hydrochlorate of ammonia and quicklime in a glass retort, and collecting over mercury. In the absence of a mercurial apparatus, the gas may be generated in a Florence flask, to the mouth of which a straight glass tube is connected by means of a cork. The bottles which are to be filled with gas are to be inverted over the tube.

In this process, one equivalent or 54 parts of hydrochlorate of ammonia are decomposed by one equivalent or 28 parts of lime; and the results of the decomposition are one equivalent or 17 parts of ammonia; one equivalent or 56 parts of chloride of calcium, and one equivalent or 9 parts of water.

MATERIALS.		COMPOSITION.				RESULTS.	
1 eq. Hydrochlorate Ammonia	54	*1 eq. Ammonia*			17	1 eq. Ammonia	17
		1 eq. Hydrochloric Acid....	37	*1 eq. Chlor.*	36		
				1 eq. Hydr.	1	1 eq. Water	9
1 eq. Lime	28	*1 eq. Oxygen*			8		
		1 eq. Calcium			20	1 eq. Chloride Calcium	56
	82				82		82

If we adopt the ammonium theory, the production of ammonia in the above process may be thus explained: one equivalent or 54 parts of chloride of ammonium is decomposed by one equivalent or 28 parts of lime, and the products of the reaction are as above stated.

MATERIALS.		COMPOSITION.				PRODUCTS.	
1 eq. Chloride Ammonium	54	*1 eq. Ammonium* ..	18	*1 eq. Amm.*^{a}	17	1 eq. Ammonia......	17
				1 eq. Hydr.	1		
		1 eq. Chlorine	36				
1 eq. Lime	28	*1 eq. Oxygen*......	8			1 eq. Water	9
		1 eq. Calcium	20			1 eq. Chlor. Calcium	56
	82		82				82

But, according to Dr. Kane, ammonia is an *amidide of hydrogen*, and sal ammoniac is a *chloro-amidide of hydrogen;* and the changes are thus explained:—

MATERIALS.		COMPOSITION.				PRODUCTS.	
1 eq. Chloro-amidide Hydrogen	54	*1 eq. Amidide Hydrogen*			17	1 eq. Amidide Hydrog.	17
		1 eq. Chloride Hydr.	37	*1 eq. Hydr.*	1	1 eq. Water	9
				1 eq. Chlor.	36		
1 eq. Lime	28	....		*1 eq. Oxyg.*	8		
				1 eq. Calc.	20	1 eq. Chlor. Cal.	56
	82				82		82

Properties.—It is a colourless invisible gas, having a strong and well-known odour. It reddens turmeric paper, and changes the colour of violet juice to green; but by exposure to the air, or by the application of heat, both the turmeric paper and violet juice are restored to their original colour. The specific gravity of this gas is 0·59. By a pressure of 6·5 atmospheres, at a temperature of 50°, it is condensed into a colourless, transparent liquid. Ammoniacal gas is not a supporter of combustion, but is slightly combustible in the atmosphere, and when mixed with air or oxygen, it forms an explosive mixture. Every two volumes of ammoniacal gas require one and a half volumes of oxygen for their complete combustion. The results of the explosion are, a volume of nitrogen and some water.

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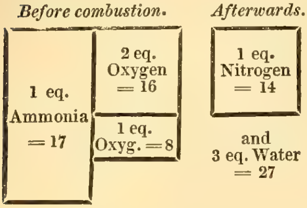
[w] De Candolle, *Physiol. Végét.* p. 339.



Characteristics.—It is readily recognised by its peculiar odour, its action on turmeric paper, and by its forming white fumes with hydrochloric acid or chlorine. Dissolved in water, it communicates a deep blue colour to the salts of copper, throws down a yellow precipitate (*platina-bichloride of ammonia*) with the bichloride of platinum, and a white one with bichloride of mercury.

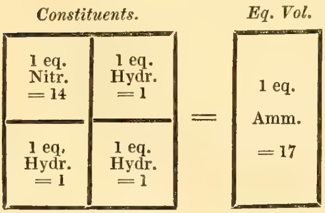
Conia agrees with ammonia in evolving a vapour which reddens turmeric paper, and forms white fumes (hydrochlorate of conia) with hydrochloric acid gas.

COMPOSITION.—Ammonia is composed of hydrogen and nitrogen, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*A. Berthollet.*
Nitrogen	1	14	82·35	81·13
Hydrogen	3	3	17·65	18·87
Ammonia	1	17	100·00	100·00

	Vol.	*Sp. Gr.*
Nitrogen gas	1	$0{\cdot}9722\dot{2}$
Hydrogen gas	3	$0{\cdot}2083\dot{3}$
Ammoniacal gas	2	$0{\cdot}5902\dot{7}$

According to Berzelius, its equivalent is 17·19 [17·15, Turner].



The annexed diagram illustrates the volumes of the constituents of the gas, and their degree of condensation when in combination to form ammoniacal gas.

Hypothetically, Dr. Kane[x] has regarded ammonia as a compound of a suppositious substance called *amidogen* (N 2H), and hydrogen: in other words, as an amidide of hydrogen.

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—Ammoniacal gas is destructive to plants, and changes their green colour to brown[y].

β. On Animals.—If an animal be immersed in this gas, spasm of the glottis is immediately brought on, and death results from asphyxia. Nysten[z] injected some of this gas into the veins of a dog:

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[x] *Transactions of the Royal Irish Academy*, vol. xix. part 1.

[y] De Candolle, *Physiol. Vég.* p. 1344.

[z] *Recherches*, p. 140.

the animal cried out, respiration became difficult, and death soon took place. Neither gas nor visible lesion was observed in the heart, the two ventricles of which contained liquid blood. In another experiment he threw ammoniacal gas into the pleura of a dog: cries, evacuation of urine, and vomiting, immediately followed; soon afterwards convulsions came on, and continued for several hours: ultimately they ceased, and recovery took place.

In almost all cases of poisoning in animals, by ammonia, or its carbonate, convulsions are observed, apparently shewing that these substances act on the spinal marrow.

γ. *On Man.*—Ammonia is a powerful local irritant. This is proved by its pungent odour, and its acrid and hot taste; by its irritating the eyes; and, when applied for a sufficient length of time to the skin, by causing vesication. If an attempt be made to inhale it in the pure form, spasm of the glottis comes on: when diluted with atmospheric air, it irritates the bronchial tubes and larynx, and, unless the quantity be very small, brings on inflammation of the lining membrane. Its powerful action on the nervous system is best seen in cases of syncope (see *Aqua Ammoniæ*).

USES.—Ammoniacal gas is rarely employed in medicine. M. Bourguet de Béziers used it with success in the case of a child affected with croup, to provoke the expulsion of the false membrane.

ANTIDOTE.—In case of the accidental inhalation of strong ammoniacal vapour, the patient should immediately inspire the vapour of acetic or hydrochloric acid. If bronchial inflammation supervene, of course it is to be treated in the usual way.

6. A'QUA AMMO'NIÆ.—WATER OF AMMONIA.

(Liquor Ammoniæ, and Liquor Ammoniæ Fortior, *L.*—Aqua Ammoniæ, and Aqua Ammoniæ Fortior, *E.*—Aqua Ammoniæ causticæ, *D.*)

HISTORY.—This solution was formerly termed *spiritus salis ammoniaci causticus cum calce viva paratus.*

PREPARATION.—It is prepared by the action of lime on either sulphate or hydrochlorate of ammonia. On the large scale, the apparatus employed is an iron cylinder, connected with the ordinary worm refrigerator, and this with a row of double-necked stoneware bottles containing water, analogous to those described under the head of nitric acid. (See p. 286.)

All the British Colleges give formulæ for its preparation. The following are the directions of the *London College*:—

"Take of Hydrochlorate of Ammonia ten ounces, Lime eight ounces, Water two pints: Put the Lime, slacked with water, into a retort, then add the Hydrochlorate of Ammonia, broken into small pieces, and the rest of the water. Let fifteen fluid ounces of solution of ammonia distil."

The *Edinburgh College* gives the following directions for preparing *Ammoniæ Aqua*, and *Ammoniæ Aqua Fortior.*

"Take of Muriate of Ammonia, thirteen ounces: Quicklime, thirteen ounces; Water, seven fluidounces and a half; Distilled Water, twelve fluidounces. Slake the Lime with the Water, cover it up till it cool, triturate it well and quickly with the Muriate of Ammonia previously in fine powder, and put the mixture into a glass retort, to which is attached a receiver with a safety tube. Connect with the receiver a bottle also provided with a safety tube, and containing four ounces of the distilled water, but capable of holding twice as much. Connect this bottle with another loosely corked, and containing the remaining eight ounces of distilled water. The communicating tubes must descend to the bottom of the bottles at the further end from the retort; and the receiver and bottles must be kept cool by snow, ice, or a running stream of cold water. Apply to the retort a gradually-increasing heat till gas ceases to be evolved; remove the retort, cork up the aperture in the receiver where it was connected with the retort, and apply to the receiver a gentle and gradually-increasing heat, to drive over as much of the gas in the liquid contained in it, but as little of the water, as possible. Should the liquid in the last bottle not have the density of ·960, reduce it with some of the stronger Aqua Ammoniæ in the first bottle, or raise it with distilled water, so as to form Aqua Ammoniæ of the prescribed density."

The *Dublin College* employs 3 parts of Muriate of Ammonia, two of fresh burned Quicklime, and ten of Water. The lime is to be slacked with one part of hot water, and then introduced into the retort, and the salt dissolved in the remaining hot water, added, and five parts distilled by a medium [between 100° and 200°] heat into a refrigerated receiver.

The theory of the process is the same as that for ammoniacal gas. An excess of lime is used to facilitate the extrication of the ammonia. The water put into the receiver is to absorb the gas.

Properties.—Solution of ammonia is a colourless liquid, having a very pungent odour, and a caustic alkaline taste. Its action on turmeric paper and violet juice is like that of ammoniacal gas before described. It is lighter than water, but its sp. gr. varies with its strength. In the shops, a very strong solution (called *Liquor Ammoniæ Fortior*) is kept, having a sp. gr. of about 0·880: it is employed for smelling-bottles. One fluidounce of Aqua Ammoniæ Fortior (sp. gr. 0·880) with three of water makes Aqua Ammoniæ of about sp. gr. 0·970 [zz]. Prepared according to the London and Edinburgh Pharmacopœias, the sp. gr. is 0·960; according to the Dublin, 0·950. A cubic inch of Liquor Ammoniæ (sp. gr. 0·960) weighs 242·36 grs., and it contains 132 cubic inches of ammoniacal gas in condensed solution. A cubic inch of Liquor Ammoniæ Fortior (sp. gr. 0·882) weighs 222·66 grs., and it holds dissolved nearly 400 cubic inches of ammoniacal gas [a]. The quantity of ammoniacal gas, which water can dissolve, varies with the pressure of the atmosphere and the temperature of the water.

Davy [b] ascertained that at the temperature of 50°, under a pressure equal to 29·8 inches, water absorbs about 670 times its volume of gas, and becomes of sp. gr. 0·875. He drew up the following table, shewing the quantity of ammonia in solutions of different specific gravities:—

100 parts of Sp. Gr.	Of Ammonia.	100 parts of Sp. Gr.	Of Ammonia.
0·8750	contain 32·50	0·9435	contain 14·53
0·8875	29·25	0·9476	13·46
0·9000	26·00	0·9513	12·40
0·9054	25·37	0·9545	11·56
0·9166	22·07	0·9573	10·82
0·9255	19·54	0·9597	10·17
0·9326	17·52	0·9619	9·60
0·9385	15·88	0·9692	9·50

It appears from the observations of Davy and Dalton that the specific gravity of mixtures of liquid ammonia and water is exactly the mean of that of the two ingredients.

[zz] In the Edinburgh Pharmacopœia it is stated that the density of the above mixture is 0·960, but this is an error. Two fluidounces of water with one fluidounce of aqua ammoniæ fortior yield a mixture whose sp. gr. is 0·960.

[a] Mr. R. Phillips's *Translation of the Pharmacopœia*, 4th edit.

[b] *Elements of Chemical Philosophy*, p. 268.

Composition.—From the above observations, the composition of officinal solutions of ammonia is nearly as follows:—

	Lond. and Edinb. Ph. (sp. gr. 0·960)	*Dub. Ph.* (sp. gr. 0·950)	*Liq. Am. Fort.* (sp. gr. 0·880)
Ammoniacal gas	10	12·5	30·5
Water	90	87·5	69·5
Liquor Ammoniæ	100	100·0	100·0

Characters.—(See *Ammoniacal Gas.*)

Impurities.—Liquor ammoniæ frequently contains traces of carbonate of ammonia, which may be detected by lime-water, or by a solution of the chloride of calcium, either of which occasions a white precipitate (*carbonate of lime*) if carbonic acid be present. When a portion of the liquid has been neutralized by pure nitric acid, it ought not to cause a precipitate by the addition of nitrate of silver, of oxalic acid, or of sesquicarbonate of ammonia: for the first would indicate the presence of hydrochloric acid, or chlorine; the second, of lime; the third, of lime, or other earthy matter. If pure, it does not effervesce with dilute acids.

Incompatibles.—It is hardly necessary to state that all acids are incompatible with ammonia. With the exception of the salts of potash, soda, lithia, baryta, and strontia, ammonia decomposes most of the metallic salts.

Physiological Effects. *α. On Vegetables.*—The effects of ammonia on plants have been before noticed.

β. On Animals.—Orfila injected sixty grains of liquor ammoniæ into the jugular vein of a strong dog: tetanic stiffness immediately came on, the urine passed involuntarily, and the animal became agitated by convulsions: death took place in ten minutes. The body was immediately opened, when the contractile power of the muscles was found extinct. In another experiment, thirty-six grains of concentrated solution of ammonia were introduced into the stomach, and the œsophagus tied: in five minutes the animal appeared insensible, but in a few moments after was able to walk when placed on his feet; the inspirations were deep, and his posterior extremities trembled. In twenty hours he was insensible, and in twenty-three hours he died. On dissection, the mucous membrane of the stomach was found red in some places. These experiments show the effects of large doses of this solution on the nervous system. The first experiment agrees in its results (that is, in causing tetanic convulsions) with that made by Nysten, and which has been before mentioned, of throwing ammoniacal gas into the cavity of the pleura. From the convulsions it may be inferred, that in these instances the (grey matter of the) spinal marrow was specifically affected.

γ. On Man. *αα. Local effects.* — In the concentrated form the local action of liquor ammoniæ is exceedingly energetic. Applied to the skin, it causes pain, redness, vesication, and destruction of the part; thus acting, first as a rubefacient, then as a vesicant, and lastly as a caustic or corrosive. Its emanations are also irritant: when they come in contact with the conjunctival membrane, a flow of tears is the result; when inhaled, their powerful action on the air-passages is well known. Persons in syncope are observed to be almost immediately raised from a death-like state, merely by inhaling the vapour of this solution. In cases of insensibility it must be employed with great caution; for, if used injudiciously, serious, or even fatal, consequences may result. Nysten[c] tells us that a physician, for some years subject to epilepsy, was found by his servant in a fit. In order to rouse his master, the latter applied a handkerchief, moistened with this solution, to his nose, so assiduously, that he brought on bronchitis, of which the patient died on the third day. In the *Edinburgh Medical and Surgical Journal*, there is the report of the case of a lad whose death was produced, or at least hastened, by an attendant applying, "with such unwearied but destructive benevolence," ammonia to the nose, that suffocation had almost resulted. Dyspnœa, with severe pain in the throat, immediately succeeded, and death took place 48 hours afterwards. A French physician also suffered ulceration of the mouth, and violent pulmonary catarrh, in consequence of the excessive use of ammonia, given as an antidote for hydrocyanic acid. More recently, another case of poisoning by the vapour of ammonia has been published[d]. It arose from the accidental bursting of a carboy of liquor ammoniæ. The mucous membrane of the nose and lips was destroyed. The tongue was deprived of its epithelium, and a large quantity of sanguineous froth escaped from the mouth. The respiration was so difficult, that suffocation was feared. The pulse was feeble, irregular, and frequent. There were no convulsions. Bronchitis supervened, but the patient recovered.

When the solution of ammonia is swallowed in large doses, it acts as a powerfully corrosive poison; but modern well-marked cases of poisoning by it in the human subject are wanting. However, it is very evident that violent inflammation of all that part of the alimentary canal with which the poison may be in contact, would be the result, and that if much were taken, decomposition of the part might be expected. When swallowed in a very dilute form, and in small quantity, the local phenomena are not very marked, and the effect of the substance is then seen in the affection of the general system.

The chemical action of ammonia on the tissues is analogous to that of potash, hereafter to be described.

ββ. Remote effects.—The remote effects may be investigated under two heads, according as they are produced by small or large doses. *In small or therapeutic doses*, such as we are accustomed to employ in the treatment of diseases, ammonia acts as a stimulant, excitant, or calefacient. It produces a sensation of warmth in the mouth, throat, and epigastrium, frequently attended with eructations. A temporary excitement of the vascular system succeeds, but this quickly subsides. The heat of the skin is sometimes increased, and there is a tendency to sweating, which, if promoted by the use of warm diluents and clothing, frequently terminates in copious perspiration. But the skin is not the only secreting organ stimulated to increased exertion; we observe the kidneys produce more urine, and frequently the quantity of bronchial mucus is increased. The nervous system is also affected, and the activity of its functions heightened. Wibmer[e] made several experiments on himself, and from them it appears that ammonia affects the head, sometimes causing oppression, or a sense of fulness, but no pain. The increased capability of muscular exertion, and the greater facility with which all the functions are executed, are further indications of the action of ammonia on the nervous system.

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[c] Christison, *Treatise on Poisons*.

Journal de Chimie Medicale, t. vi. p. 499, 2^{nde} Sér.

There is, however, something remarkably different between the stimulant effects of ammonia and those of alcohol or opium. The first may be employed with great benefit in many inflammatory and febrile cases, in which the latter proves highly prejudicial. Ammonia, observes Dr. Billing[f], is *not*, like wine and tincture of opium, a diffusible stimulant. "In the first place, ammonia is used empirically by the most able of the profession, in cases where they know from experience that they must not employ wine or tincture of opium. This alone shows that it is not really a diffusible stimulant—it is a local one; and as such, through the medium of the solar plexus, excites the heart momentarily, though not injuriously. Again, so far from being a diffusible stimulus, it immediately unites with animal acids, and then circulates, or is *diffused*, not as a stimulant, but as a *sedative* saline; so as to perform the double operation of a temporary local stimulant to the stomach and heart, and a sedative to inflamed capillaries elsewhere, although the latter indication be not contemplated in its administration."

The effects of large or poisonous doses on the human subject have not been described: but that the nervous system is affected, seems probable from a case mentioned by Plenck[g], which terminated fatally in four minutes; though the symptoms are not related. (See *Ammoniæ Sesquicarbonas.*)

If we compare the effects of ammonia with those of other stimulants, as camphor, wine, and opium, we observe, in the first place, that the influence of ammonia is principally manifested in the ganglionic and true spinal systems,—while the other stimulants, above mentioned, affect the cerebral system. Thus the effects of ammonia are usually exhibited on the circulation, respiration, secretion, and spasmodic actions: but camphor, wine, and opium, though they also affect these functions, yet they principally affect the intellectual functions. Secondly, the effects of ammonia are more transient than those of the other agents just referred to. Thirdly, the vascular excitement caused by wine and opium is attended with diminished mucous secretion, and is allied more to an ordinary febrile attack.

USES.—Ammonia is adapted for speedily rousing the actions of the vascular and respiratory systems, and for the prompt alleviation of spasm. It is more especially fitted for fulfilling these indications when our object is at the same time to promote the action of the skin. It is calculated for states of debility with torpor or inactivity. It is also used as an antacid and local irritant.

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[e] *Die Wirkung*, &c. Bd. i. S. 123.
[f] *First Principles of Medicine*, p. 158, 4th ed. Lond. 1841.
[g] *Toxicologia*, p. 226, Ed. 2nda. Viennæ, 1801.

1. *In dyspeptic complaints, accompanied with preternatural acidity of stomach and flatulence*, but without inflammation, a properly diluted solution of ammonia may be employed with a two-fold object—that of neutralizing the free acid, and of stimulating the stomach. It must be remembered that the healthy secretions of the stomach are of an acid nature, and that the continued use of ammonia, or any other alkali, must ultimately be attended with injurious results, more especially to the digestive functions. While, therefore, the occasional employment of alkalis may be serviceable, their constant or long-continued use must ultimately prove deleterious.

Ammonia may, under some circumstances, be employed to neutralize acids introduced into the stomach from without, as in poisoning by the mineral acids, though chalk and magnesia would be more appropriate, being less irritant. It is a valuable antidote in poisoning by hydrocyanic acid. Its beneficial operation has been ascribed to the union of the alkali with the acid, whereby hydrocyanate of ammonia is formed; but since it has been found that this salt is highly poisonous, it is evident that this explanation is not satisfactory. Some have ascribed the activity of the hydrocyanate to its decomposition by the free acids of the stomach, and the consequent evolution of free hydrocyanic acid; but this explanation is not satisfactory. I believe the efficiency of ammonia as an antidote to poisoning by hydrocyanic acid, arises from its exerting an influence of an opposite nature to that of the poison. In poisoning by the oil of bitter almonds, or other agents supposed to contain this acid, ammonia is equally serviceable. The antidote should be given by the stomach, if the patient can swallow, and the vapour should be cautiously inhaled.

2. *To produce local irritation, rubefaction, vesication, or destruction of the part.*—As a *local agent*, ammonia has been employed in a variety of diseases, sometimes as a rubefaciant or irritant, sometimes as a vesicant, and occasionally as a caustic. Thus it is employed as a rubefacient in rheumatic and neuralgic pains, and as a counter-irritant to relieve internal inflammations. As a local irritant, a weak solution has been injected into the vagina and uterus, to excite the catamenial discharge; but there are some objections to its use. Thus, it is a most unpleasant kind of remedy, especially to young females; moreover, the stoppage of this discharge is in many cases dependent on constitutional or remote causes, and, therefore, a topical remedy is not likely to be beneficial. Lavagna employed ten or fifteen drops of the solution, diluted with milk. The following is Nisato's formula:—

℞ Ammon. liquid. gtt. xl.; Decoct. Hordei, unc. viii.; Mucilag. Arab. unc. dimid. Misce, et fiant quatuor intra diem injectiones.

Sometimes ammonia is employed as a vesicatory; and it has two advantages over cantharides—a more speedy operation, and non-affection of the urinary organs. It may be employed in the form of ointment or solution. As a caustic, the strong solution of ammonia may be sometimes used with advantage in the bites of rabid animals.

3. *The vapour of the solution of ammonia may be inhaled* when we wish to make a powerful impression on the nervous system, as in syncope, or to prevent an attack of epilepsy. To guard against or relieve fainting, ammoniacal inhalations are very powerful and useful; their instantaneous operation is frequently astonishing. Pinel says, he once saw an attack of epilepsy prevented by this means. The patient (a watchmaker) had intimations of the approaching paroxysm from certain feelings; but he found, by inhaling the vapour of ammonia, it was frequently prevented. In the case of a confirmed epilepsy, which I was in the habit of watching for some years, I think I have also seen analogous beneficial effects. I speak doubtfully, because it is so difficult to determine, in most cases, the actual approach of the fit. It is deserving of especial notice, that ammonia is useful in three conditions of system, which, though produced by very different causes, present analogous symptoms; viz. idiopathic epilepsy—the insensibility and convulsions (? epilepsy) produced by loss of blood—and the insensibility and convulsions (? epilepsy) which poisonous doses of hydrocyanic acid give rise to. (See *Ammoniæ Sesquicarbonas*).

In asphyxia, ammoniacal inhalations have been strongly recommended by Sage, who says that he produced the apparent death of rabbits by immersion in water, and recovered them subsequently by the use of ammonia. A case is told us of a man who had been submerged in the Seine for twenty minutes, and who, when taken out of the water, appeared lifeless, yet by the use of ammonia recovered; and a M. Routier, a surgeon, of Amiens, is said to have restored a patient in the same way. That it may sometimes be of service I can readily believe, but it must be employed with great caution.

4. *Ammonia is given internally as a stimulant and sudorific* with manifest advantage in several cases, of which the following are illustrations:—

α. In continued fevers which have existed for some time, and where all violent action has subsided, and the brain does not appear much disordered, it is occasionally of great service. Its diaphoretic action should be promoted by diluents and warm clothing. It has an advantage over opium—that, if it do no good, it is less likely to do harm.

β. In intermittent fevers it is sometimes of advantage, given, during the cold stage, to hasten its subsidence.

γ. In the exanthemata, when the eruption has receded from the skin, and the extremities are cold, it is sometimes of great benefit, on account of its stimulant and diaphoretic properties. But in many of these cases the recession arises from, or is connected with, an inflammatory condition of the bronchial membrane, for which the usual treatment is to be adopted.

δ. In some inflammatory diseases (especially pneumonia and rheumatism), where the violence of the vascular action has been reduced by proper evacuations, and where the habit of the patient is unfavourable to the loss of blood, ammonia has been serviceable. In combination with decoction of senega, I have found it valuable in old pulmonary affections. (See *Senega.*)

5. *In certain affections of the nervous system*, ammonia is frequently employed with the greatest benefit. Thus it has been used to relieve the cerebral disorder of intoxication. In poisoning by those cerebro-spinants commonly termed sedatives—such as foxglove, tobacco, and hydrocyanic acid, ammonia is a most valuable agent. This remedy has been supposed to possess a specific influence in relieving those disorders of the nervous system accompanied with spasmodic or convulsive symptoms; and hence it is classed among the remedies denominated *antispasmodic.* Velsen, of Cleves, has used it with advantage in delirium tremens. It was a remedy frequently tried in the malignant or Indian cholera, and occasionally procured relief, but it was not much relied on.

6. *Against the bites of poisonous animals*—as serpents and insects, ammonia is frequently employed with the best effects. There does not appear, however, any ground for the assertion of Sage, that it is a specific: in fact, Fontana declares that it is sometimes hurtful in viper bites[h].

ADMINISTRATION.—It is given in doses of from five to twenty or thirty drops, properly diluted.

ANTIDOTES.—The diluted acids—as vinegar, lemon or orange juice, &c., are antidotes for ammonia. To abate the inflammatory symptoms caused by the inhalation of its vapour, blood-letting has been found serviceable.

1. LINIMENTUM AMMONIÆ, L. E. D.; *Liniment of Ammonia; Volatile Liniment; Oil and Hartshorn.* (Solution of Ammonia, f℥j. [f ʒij. *D.*]; Olive Oil, f℥ij. Mix and shake them well together).—This is an *ammoniacal soap* composed of the *oleo-margarate of ammonia* mixed with some *glycerine*[i]. It is employed as an external stimulant and rubefacient, to relieve rheumatic and neuralgic pains, lumbago, sore throat, sprains, bruises, &c.

2. LINIMENTUM AMMONIÆ COMPOSITUM, E.; *Compound Liniment of Ammonia.* (Stronger solution of Ammonia [sp. gr. 0·880], f ʒv.; Tincture of Camphor, f℥ij.; Spirit of Rosemary, f℥j. Mix them well together. This liniment may be also made weaker for some purposes, with three fluidounces of Tincture of Camphor and two of Spirit of Rosemary).—These are obvious imitations of Dr. Granville's *counter-irritating* or *antidynous lotions*[j]. This liniment may be used so as to produce rubefaction, vesication, or cauterization. A piece of linen six or seven times folded, or a piece of thick and coarse flannel impregnated with this liniment, is to be applied to the part and covered with a thick towel, which is to be firmly pressed against the part. If rubefaction merely be desired, the application is continued for from one to six or eight minutes; but from ten to twelve minutes are necessary to excite vesication and cauterization. In painful and spasmodic affections, as neuralgia, cramp, &c.; in rheumatism, lumbago, and swollen and painful affections of the joints; in headache, sore throat, sprains, and many other cases, benefit may be obtained from a powerful and speedy counter-irritant like this, as stated by Dr. Granville.

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[h] For some other uses of ammonia, see *Ammoniæ Sesquicarbonas.*

[i] See the articles *Soap* and *Olive Oil.*

[j] *Lancet*, October 27, 1838; and *Brit. and Foreign Med. Review*, vol. vii. p. 292.—Also Dr. Granville's work, entitled *Counter-irritation, its Principles and Practice, illustrated by one hundred cases of the most painful and important Diseases effectually cured by external applications.* Lond. 1838.

3. **UNGUENTUM AMMONIÆ**; *Liparolé d'Ammoniaque; Pommade Ammoniacale de Gondret; Gondret's Ammoniacal Ointment.*—The formula for this, as given by Soubeiran[k], is as follows:—Suet one part, Hog's Lard one part, and Strong Solution of Ammonia two parts. In Gondret's[l] work, however, the following formula is given:—Hog's Lard, ʒvij., Oil of Sweet Almonds, ʒiss., and Strong Liquid Ammonia, from ʒv. to ʒvj. Melt the lard, mix it with the oil, and pour them into a wide-mouthed bottle with a ground glass stopper; then add the ammonia, close the bottle, mix the contents together by shaking, and keep the mixture in a cool place.—This ointment, rubbed on the skin and covered by a compress, speedily produces vesication. Without the compress it causes rubefaction. It is a very useful rubefacient, vesicant, and counter-irritant.

4. **TINCTURA AMMONIÆ COMPOSITA**, L. *Spiritus Ammoniæ succinatus.* (Mastic, ʒij.; Rectified Spirit, f℥ix.; Oil of Lavender, ♏xiv.; Oil of Amber, ♏iv.; Stronger Solution of Ammonia, Oj. Macerate the Mastic in the Spirit, that it may be dissolved, and pour off the clear tincture; then add the other ingredients, and shake them all together.)—This liquid is milky, owing to the separation of the mastic from its spirituous solution by ammonia. It is commonly called *Eau de Luce* (*Aqua Luciæ*), after an apothecary at Lille. M. B. Jussieu[m] gave it to one of his pupils who had been bitten by a viper; and, as the patient recovered, the remedy acquired considerable celebrity as a counter-poison to the bites of venomous snakes. But Fontana[n] has shown, that ammonia (its active principle) does not possess any powers of this kind. The compound tincture of ammonia is a powerful antispasmodic stimulant, and is now principally employed as an antihysteric, in doses of from ten to thirty or forty minims. It has also been used as a stimulating embrocation.

7. AMMO'NIÆ CAR'BONAS.—CARBONATE OF AMMONIA.

HISTORY.—Both solid and liquid compounds of ammonia and carbonic acid have been known for several centuries. Raymond

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[k] *Nouveau Traité de Pharmacie,* t. ii. p. 302, 2nde éd. Paris, 1840.

[l] *Traité Théorique et Pratique de la Dérivation contre les Affections les plus communes en général, telle la Pléthore, l'Inflammation, l'Hémorrhagie,* &c. Paris, 1837. Reviewed in *Brit. and For. Medical Review,* vol. vii. p. 56.

[m] *Histoire de l'Académie Royale des Sciences.* Année 1747, p. 54.

[n] *Treatise on the Venom of the Viper,* vol. ii. Lond. 1787.

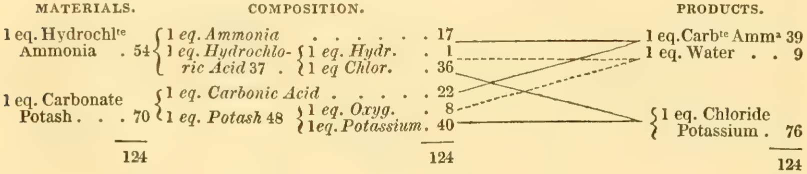
Lully, in the 13th century, was acquainted with the impure solution of carbonate of ammonia obtained from putrid urine; and it is probable that the Arabians had known it long before. Basil Valentine[°] speaks of the *spiritus salis urinæ.*

Natural History (see *Ammonia*, p. 294).—Carbonate of ammonia is formed during the putrefaction or destructive distillation of those organic substances which contain nitrogen. It is a constituent of rain water (see p. 259).

Preparation.—Anhydrous neutral carbonate of ammonia can only be obtained by bringing together dry carbonic acid and ammoniacal gases. It is not employed in medicine.

Hydrated neutral carbonate of ammonia is the first, and, therefore, the most volatile, of the solid products which appear in the distillation of the commercial hydrated sesquicarbonate of ammonia. If hydrated sesquicarbonate of ammonia be digested in a small quantity of water, we obtain a solution of a neutral carbonate of ammonia, mixed, however, with a little of the bicarbonate.

The same neutral carbonate is obtained when a mixture of sal ammoniac and carbonate of either soda or potash is submitted to distillation with water; and on this principle several liquid preparations (presently to be mentioned) of this neutral salt are directed to be prepared in the Pharmacopœia. One equivalent or 54 parts of the hydrochlorate of ammonia react on one equivalent or 70 parts of carbonate of potash, and yield one equivalent or 76 parts of chloride of potassium, one equivalent or 9 parts of water, and one equivalent or 39 parts of carbonate of ammonia.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Hydrochlte Ammonia . 54
1 eq. Ammonia 17
1 eq. Hydrochloric Acid 37 .
1 eq. Hydr. . 1
1 eq Chlor. . 36
1 eq. Carbonate Potash . . . 70
1 eq. Carbonic Acid 22
1 eq. Potash 48
1 eq. Oxyg. . 8
1 eq. Potassium. 40
124
124
1 eq. Carbte Amma 39
1 eq. Water . . 9
1 eq. Chloride Potassium . 76
124

Bone spirit, obtained by the destructive distillation of bones, contains neutral carbonate of ammonia in solution with animal empyreumatic oil.

Properties.—Hydrated neutral carbonate of ammonia is a crystalline salt, having an ammoniacal odour, but weaker than that of a solution of caustic ammonia.

Characteristics.—Its solution yields, on the addition of chloride of barium, a white precipitate (*carbonate of baryta*): and no further precipitate is obtained by the further addition of caustic ammonia to the mixture. This character distinguishes the neutral carbonate from the sub- and super-carbonates of ammonia (see *Hydrated Sesquicarbonate* and *Bicarbonate of Ammonia*).

Composition.—The hydrated neutral carbonate of ammonia has, according to Rose, the following composition:—

[°] *Chymische Schriften*, Ander-Theile, S. 392. Hamb. 1677.

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Rose.*
Ammonia	2	34	39·080	39·27
Carbonic Acid	2	44	50·575	50·09
Water	1	9	10·345	10·64
Hydrated Carbonate of Ammonia	1	87	100·000	100·00

Or	*Atoms.*	*Eq.Wt.*	*Per Cent.*
Carbonate of Ammonia	1	39	44·83
Carb. of Oxide of Ammonium	1	48	55·17
	1	87	100·00

Physiological Effects and Uses.—The effects of carbonate of ammonia are similar to, but somewhat milder than, those of caustic ammonia. The neutral carbonate is more powerful than the hydrated sesquicarbonate, and still more so than the bicarbonate of ammonia. In the solid form it is not employed in medicine. Several officinal preparations, however, owe their medicinal activity to it.

1. **SPIRITUS AMMONIÆ**, L. E. D. *Spirit of Ammonia.*—Prepared according to the London and Dublin Pharmacopœias, this is a solution of carbonate of ammonia in rectified spirit; but according to the Edinburgh Pharmacopœia it is a solution of ammoniacal gas in spirit. The following are the formulæ of the three colleges:—

The *London College* orders Hydrochlorate of Ammonia, ℥x.; Carbonate of Potash, ℥xvj.; Rectified Spirit; Water; of each Oiij. Mix, and let three pints distil.—In this process double decomposition takes place (as above explained), and the carbonate of ammonia, which is produced, distils over with the spirit, in which the greater part of it dissolves; the remainder being deposited in an imperfectly crystalline state.

The *Dublin College* directs [Sesqui-] Carbonate of Ammonia, coarsely powdered, ℥iijss. to be dissolved, with a medium heat, in Rectified Spirit, Oiij. [*wine measure*].—During the solution in the heated spirit, the sesqui-carbonate evolves carbonic acid gas, and is reduced to the state of carbonate of ammonia, of which about 30 grains are taken up by each ounce measure of the spirit.

The *Edinburgh College* orders Rectified Spirit, Oij. & f ʒij.; Fresh-burnt Lime, ℥xij.; Muriate of Ammonia, in very fine powder, ℥viij.; Water, f℥viss. Let the lime be slaked with the water in an iron or earthenware vessel, and cover the vessel till the powder be cold; mix the lime and muriate of ammonia quickly and thoroughly in a mortar, and transfer the mixture at once into a glass retort; adapt to the retort a tube which passes nearly to the bottom of a bottle containing the rectified spirit; heat the retort in a sand-bath gradually, so long as any thing passes over, preserving the bottle cool. The bottle should be large enough to contain one-half more than the spirit used.—In this process we obtain, by the mutual reaction of the sal ammoniac and lime[p], ammoniacal gas, which passes over, and is dissolved in the spirit contained in the receiver.

The medicinal effects of this preparation are analogous to those of Liquor Ammoniæ. It may be employed in hysteria, flatulent colic, and nervous debility. It is, however, but little used except in the preparation of the following compounds. The dose of it is from f ʒss. to f ʒj. properly diluted with water. Saturated with camphor it forms a highly stimulating liniment.

2. **SPIRITUS AMMONIÆ FŒTIDUS**, L. E. D. *Fetid Spirit of Ammonia.*—In this, as in the preceding preparation, a difference exists in the formulæ of the British Colleges. The London and Dublin Colleges use a solution of carbonate of ammonia, while the Edinburgh College employs a solution of caustic ammonia.

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[p] See p. 295.

The formula of the *London College* is the same as that for Spiritus Ammoniæ, *L.*; except that five ounces of Asafœtida are put into the retort with the other ingredients.

The *Dublin College* orders Asafœtida ℥iss. to be macerated for three days in Spirit of Ammonia, Oij. [*wine measure*], shaking occasionally; then pour off the clear liquor, and distil a pint and a half.

The *Edinburgh College* employs Spirit of Ammonia, f℥xss.; Asafœtida, ℥ss. Break the Asafœtida into small fragments; digest it in the spirit for twelve hours; and distil over ten fluid ounces and a half by means of a vapour-bath heat.

This preparation is a very unnecessary one. It is merely a solution of the volatile oil of the asafœtida in spirit of ammonia; for which a mixture of tincture of asafœtida and spirit of ammonia may be conveniently and more efficaciously substituted. It is a colourless, pungent, and fetid liquor, which becomes brownish by age. It is employed in hysteria, in doses of from half a drachm to a drachm in water.

3. SPIRITUS AMMONIÆ AROMATICUS, L. E. D. *Spirit of Sal Volatile.*—The preparation of the London and Dublin Pharmacopœias is a solution of the carbonate of ammonia; but that of the Edinburgh Pharmacopœia contains caustic ammonia.

The *London College* gives the following formula:—Hydrochlorate of Ammonia, ℥v.; Carbonate of Potash, ℥viij.; Cinnamon, bruised; Cloves, bruised, of each ʒij.; Lemon Peel, ℥iv.; Rectified Spirit; Water, of each Oiv. Mix them, and let six pints distil.—In this process double decomposition takes place, as already noticed, and the carbonate of ammonia distils over with the spirit and part of the water flavoured by the essential oils of the aromatics used.

The *Dublin College* orders spirit of Ammonia, Oij. [*wine measure*]; Essential Oil of Lemons, ʒij.; Nutmegs bruised, ℥ss.; Cinnamon Bark, bruised, ʒiij. Macerate in a close vessel for three days, shaking occasionally; then distil a pint and a half.

The *Edinburgh College* orders of Spirit of Ammonia, f℥viij.; Volatile Oil of Lemon-peel, fʒj.; Volatile Oil of Rosemary, fʒiss. Dissolve the oils in the spirit by agitation.

This preparation, on account of its more agreeable taste and smell, is usually preferred to the Spiritus Ammoniæ above noticed, than which it is somewhat weaker. It is frequently employed in languors, faintings, hysteria, flatulent colic, and nervous debility, in doses of from fʒss. to fʒij. properly diluted with water.

8. AMMOʹNIÆ SESQUICARBOʹNAS, *L.*—SESQUICARBONATE OF AMMONIA, *E.*

(Ammoniæ Carbonas, *E. D.*)

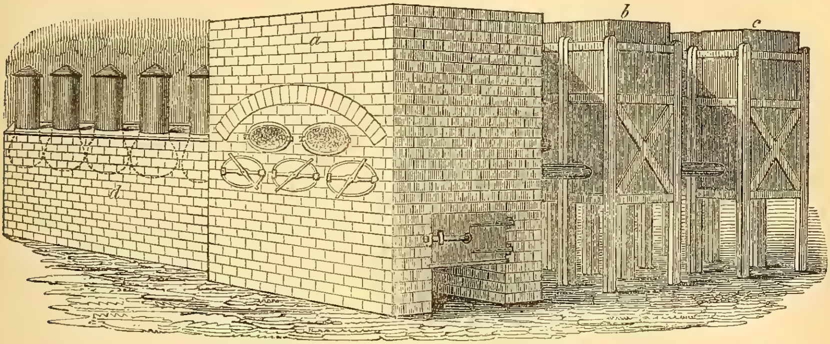
History.—This salt was probably known to Raymond Lully; but until late years it has been confounded with the other carbonates of ammonia. It is frequently denominated *subcarbonate of ammonia*, *volatile* or *smelling salts*, or *baker's salt*. The last appellation has been given to it because of its use by bakers, as a substitute for yeast, in the manufacture of some of the finer kinds of bread.

It is probable that the terms *sal alkali volatile siccum* seu *urinosum*, *sal volatile salis ammoniaci*, and *sal volatile cornu cervi*, applied to this rather than any other carbonate of ammonia.

Natural History.—See *Ammonia* (p. 294), and *Ammoniæ Carbonas* (p. 305).

Preparation.—Manufacturers prepare it by submitting to sublimation a mixture of sal ammoniac or impure sulphate of ammonia and chalk. A few years since, it was extensively made at Messrs. Bush & Co.'s, Bow Common. The retorts in which the sublimation was effected, were of cast iron, and similar in shape and size to those employed in the manufacture of coal gas. Each retort communicated posteriorly with a leaden receiver, with which was connected a second receiver of the same size and shape. The receivers had the form of square prisms placed endways, and were supported in a wooden frame-work. The impure sesquicarbonate thus obtained was contaminated with tar or oily matter, and deposited a dark carbonaceous matter when dissolved in acids. It was refined in iron pots, surmounted with leaden heads, and heated by the flue of the retort furnace. A little water is introduced into the pots to render the sesquicarbonate translucent. In another manufactory, which I have inspected, the pots are heated by a water-bath; a temperature of 150° F. being, I am informed, sufficient for this process.

Fig. 54.

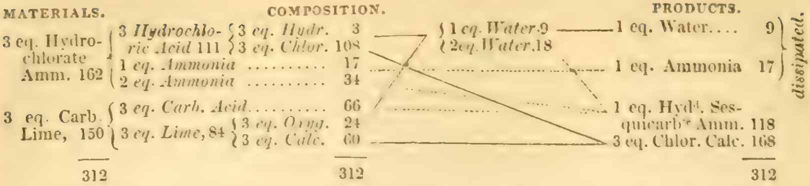


Manufacture of Sesquicarbonate of Ammonia.

a. Retort furnace. *b.* First leaden receiver. *c.* Second ditto. *d.* Refining pots.

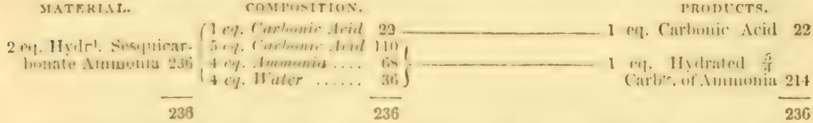
All the British Colleges give formulæ for the preparation of this salt. The *London* and *Edinburgh Colleges* order of Hydrochlorate of Ammonia, lb.j., and Chalk lbiss. These are to be rubbed separately to powder, then mixed, and submitted to sublimation with a heat gradually increased. The *Dublin College* orders equal parts of Muriate of Ammonia, and dried Carbonate of Soda.

In this process three equivalents or 162 parts of sal ammoniac react on three equivalents or 150 parts of carbonate of lime, and produce an equivalent or 118 parts of the hydrated sesquicarbonate of ammonia, three equivalents or 168 parts of chloride of calcium, one equivalent or 17 parts of ammonia, and one equivalent or 9 parts of water. The chloride of calcium is left in the retort, the hydrated sesquicarbonate of ammonia is sublimed, while the ammonia and the water are dissipated.



It appears from some experiments, presently to be noticed, that the compound called hydrated sesquicarbonate of ammonia is a double salt, consisting of one equivalent of anhydrous carbonate of ammonia (NH^3, CO^2) and one equivalent of hydrated bicarbonate of ammonia ($NH^3, 2\ CO^2, 2\ HO$). Now in general, when two neutral salts react on each other, the resulting compounds are also neutral: and, therefore, by the mutual action of 3 equivalents of hydrochlorate of ammonia and 3 equivalents of carbonate of lime, the calculated products should be 3 equivalents of hydrated neutral carbonate of ammonia (NH^3, CO^2, HO), called hypothetically carbonate of the oxide of ammonium, and 3 equivalents of chloride of calcium. But it appears from Rose's experiments[q] that such a hydrated neutral carbonate of ammonia does not exist *per se*. Hence at the commencement of the heating process ammoniacal gas escapes with just so much water as is sufficient to form the hypothetical oxide of ammonium.

Hydrated sesquicarbonate of ammonia cannot be re-sublimed unchanged. Hence in the process of refining, its constitution changes; every two equivalents lose an equivalent of carbonic acid, and the product is a hydrated $\frac{5}{4}$ carbonate of ammonia.



PROPERTIES.—Hydrated sesquicarbonate of ammonia is met with in the form of fibrous, white, translucent cakes, about two inches thick. When exposed to the air it evolves carbonate of ammonia, and is converted into bicarbonate of ammonia; so that its vapour has a pungent odour, and strongly reddens turmeric paper. The resulting hydrated bicarbonate is opaque, pulverulent, and much less pungent, from which it has been termed *mild carbonate of ammonia*. The sesquicarbonate is soluble in four times its weight of cold water; but boiling water or alcohol decomposes it, with the evolution of carbonic acid.

Characteristics.—As an ammoniacal salt, this substance is recognised by its odour, its fugacious action on turmeric paper, and by its action on the salts of copper, bichloride of platinum, and bichloride of mercury (see tests for ammonia, p. 296). As a carbonate it is known by its solution yielding a white precipitate (*carbonate of baryta*) with the chloride of barium: the clear liquor from which this precipitate has subsided, yields a further precipitate on the addition of caustic ammonia. By this last character the sesquicarbonate is distinguished from the neutral carbonate.

COMPOSITION.—This salt consists, according to Mr. Phillips[r],

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[q] Taylor's *Scientific Memoirs*, vol. ii.

[r] *Quarterly Journal of Science*, vol. vii. p. 294

Dr. Thomson, and Rose, of carbonic acid, ammonia, and water, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Centage.*	*R. Phillips.*
Carbonic Acid	3	66	55·93	54·2
Ammonia	2	34	28·81	29·3
Water	2	18	15·26	16·5
Hydrated Sesquicarbonate of Ammonia	1	118	100·00	100·0

It appears, however, from the observations of Dalton[s] and Scanlan[t], that it is not a single salt or true sesquicarbonate, but a mixture or compound of the carbonate and bicarbonate; for if treated with a small quantity of cold water, a solution of carbonate of ammonia is obtained, while a mass of bicarbonate having the form and dimensions of the sesquicarbonate employed, and of which it is a mere skeleton, is left. Two circumstances appear to me to prove that it is not a mere mixture, but a true chemical combination of these salts; viz. first the uniformity of its composition, and secondly its crystalline structure. Its constitution, then, is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Anhydrous Carbonate of Ammonia	1	39	33·05
Hydrated Bicarbonate of Ammonia	1	79	66·95
Hydrated Sesquicarbonate of Ammonia	1	118	100·00

IMPURITY.—The hydrated sesquicarbonate of ammonia of commerce is sometimes contaminated with empyreumatic oil, and in this state it yields a more or less deeply-coloured, or even blackish, solution when dissolved in dilute acid. The pure salt, on the other hand, yields a colourless solution, and leaves no residuum when heated on platinum or glass. It is translucent and crystalline; but when exposed to the air it evolves carbonate of ammonia, and becomes opaque, pulverulent, and less pungent: in this state it consists principally of bicarbonate of ammonia. Lastly, its aqueous solution, saturated with pure nitric acid, gives no precipitate with solution of chloride of barium or of nitrate of silver; for a precipitate with the first of these substances would indicate the presence of a sulphate, with the second a chloride.

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—The principal experimenters with this salt are Seybert, Orfila, and Gaspard, on dogs, and Wibmer on man. Seybert[u] injected in one experiment fifteen grains, in a second twenty-five grains, and in a third experiment forty-five grains of this salt, dissolved in a little water, into the crural vein of a dog: the animal appeared to suffer great pain; the frequency of the heart's action was increased, the respiration became difficult, and violent convulsions came on; but in all these cases perfect recovery took place. The blood, drawn after the injection, had its natural colour, odour, and consistence. Orfila[v] found that two drachms and a half of the salt, given to a dog, caused gastric inflammation, with tetanic convulsions; the body ultimately becoming curved, with the head forcibly bent backwards. Gaspard (quoted by Wibmer[w]) killed a young pig, of three weeks old, by injecting twenty-four drops of (a solution of) carbonate of ammonia in an ounce of water into the veins. Death occurred in nine hours.

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[s] *Memoirs of the Literary and Philosophical Society of Manchester*, 2nd Ser. vol. iii. p. 18.

[t] *Athenæum* for 1838, p. 596.

[u] Quoted by Wibmer, *Die Wirkung*, &c.

[v] *Toxicol. Générale.*

β. *On Man.*—Wibmer found that a grain and a half of this salt produced on himself no remarkable effect; three grains increased the frequency of the pulse from 68 to 72 beats per minute, with throbbing headache. In other experiments, in which he took from six to twelve grains (in some repeating the dose at short intervals), the effects were usually, but not constantly, increased frequency of pulse, with disorder of brain, manifested by the pain, heaviness, throbbing, &c. In one instance, he says, disposition to cough, and increased secretion of bronchial mucus, were remarkable. To an epileptic patient (a female) in the London Hospital, I gave fifteen grains of this salt three times a day for two months, without any apparent injury. The fits, which previously had occurred at stated periods, were suspended during the time the patient was under the influence of the medicine. Huxham[x] has mentioned a remarkable case illustrative of the ill effects resulting from the long-continued use of this salt.

> "I had lately under my care," he observes, "a gentleman of fortune and family, who so habituated himself to the use of vast quantities of the volatile salts, that at length he could eat them in a very astonishing manner, as other people eat sugar and caraway seeds. The consequence was that he brought on a hectic fever, vast hæmorrhages from the intestines, nose, and gums; every one of his teeth dropped out, and he could eat nothing solid; he wasted vastly in his flesh, and his muscles became as soft and flabby as those of a new-born infant; and he broke out all over his body in pustules. His urine was always excessively high coloured, turbid, and very fetid. He was at last persuaded to leave off this pernicious custom; but he had so effectually ruined his constitution, that, though he rubbed on in a miserable manner for several months, he died, and in the highest degree, of marasmus. And I am persuaded he would have died much sooner, had he not constantly drank very freely of the most fine and generous wines, and daily used large quantities of asses' milk, and anti-scorbutic juices, acidulated with juice of lemon."

The general action of this salt is similar to that of caustic ammonia, already noticed. Its topical operation, however, is less intense; for combination with carbonic acid diminishes the local action of ammonia in proportion to the quantity of acid present.

In small doses it proves antacid, stimulant, and sudorific. By repeated use it operates as a liquefacient (see p. 194), like the other alkalis, though much less intensely so. In doses of thirty grains or more it is apt to occasion vomiting. The effects of an over-dose are abdominal pains, and other symptoms of inflammation, convulsions, and other phenomena indicative of its action on the nervous system.

Uses.—It is used in the same cases and under the same regulations as the solution of ammonia, to which I must refer the reader (see p. 302).

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[w] *Die Wirkung,* &c.

[x] *Essay on Fevers,* pp. 48 and 308, 3d edit. 1757.

Recently this salt has been recommended, by Dr. Barlow[y], in *diabetes*, several cases of which are said to have been relieved, if not cured, by it. I regret that I cannot confirm Dr. Barlow's favourable notice of it. In one case (that of a man, an out-patient at the London Hospital) it has, in my hands, failed to give any relief, after a prolonged trial.

It has been employed with excellent effect in some cases of *scrofula*[z]. It is best adapted for those cases attended with a languid circulation and a dry state of skin.

It is frequently employed for the preparation of effervescing draughts. The following are the relative proportions of acid and base to be used:—

20 grains of Sesquicarbonate of Ammonia require	6	fluidrachms of Lemon Juice, or
	24	grains of crystallized Citric Acid, or
	25½	grains of crystallized Tartaric Acid.

The citrate and tartrate of ammonia thus obtained are useful remedies in febrile cases, where the object is to promote cutaneous circulation and exhalation.

Full doses of this salt have been employed in *paralysis*, to occasion vomiting.

Mixed with some aromatic oil (as the oil of bergamot or lavender), it is used as *a smelling salt*, against syncope, hysteria, &c.

As a topical agent it has been employed in aqueous solution, or mixed with oil to form an imperfect kind of soap, or made into ointment with lard. Its operation in these cases is that of a topical stimulant and rubefacient. It proves useful in rheumatic pains, sprains, &c.

ADMINISTRATION. — As a stimulant and diaphoretic, it is used in doses of from five grains to a scruple, exhibited either in the form of pill or of solution. As an emetic, the dose is 30 grains, properly diluted, and repeated if necessary.

ANTIDOTES.—(See *Ammonia*, p. 304.)

1. **LIQUOR AMMONIÆ SESQUICARBONATIS**, L. *Ammoniæ Carbonatis Aqua*, E. D. (Sesquicarbonate of Ammonia, ℥iv. [4 parts, *D.*]; Distilled Water, Oj. [15 parts, *D.*] Dissolve and filter).—By exposure to the air, this solution loses its pungency by the formation of bicarbonate of ammonia. It may be given internally in doses of from f ʒss. to f ʒiss., or even f ʒij. properly diluted. It is employed in the preparation of Ferri Potassio-tartras, *Ph. L.*, and is a constituent of the following liniment:—

2. **LINIMENTUM AMMONIÆ SESQUICARBONATIS**, L. *Liniment of Sesquicarbonate of Ammonia.* (Solution of Sesquicarbonate of Ammonia, f℥j.; Olive Oil, f ℥iij. Shake them together until they are mixed).—Oil and sesquicarbonate of ammonia form a soap, but, owing to the presence of the carbonic acid, it is of an imperfect kind. Its effects

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Guy's Hospital Reports, vol. v.

[z] *An Essay on Scrophula; in which an Account of the Effect of the Ammoniæ Carbonas, as a Remedy in that Disease, is submitted to the Profession.* By Charles Armstrong, M.D. Lond. 1812.

and uses are analogous to the *Linimentum Ammoniæ* before mentioned (p. 304).

9. AMMO'NIÆ BICAR'BONAS, *D.*—BICARBONATE OF AMMONIA.

History.—This salt was formed by Berthollet, and hence it is sometimes termed *Berthollet's neutral carbonate of ammonia.*

Preparation. — The directions of the Dublin College for its preparation, are as follows:—

> "Take of Water of Carbonate of Ammonia any required quantity. In a suitable apparatus let the water be exposed, until the alkali is saturated, to the stream of Carbonic Acid Gas which escapes during the solution of white marble in diluted Muriatic Acid. Then let it rest, and let crystals form, which are to be dried without heat, and preserved in a close vessel."

Bicarbonate of Ammonia is also formed by keeping the common sesquicarbonate of ammonia in imperfectly closed vessels. Another mode of obtaining it is by digesting water on the sesquicarbonate: the more soluble carbonate is dissolved, leaving the less soluble bicarbonate (see p. 311).

Properties.—The crystals of this salt belong to the *right rhombic system*[a]. Their smell and taste are very faintly ammoniacal. This salt is less soluble in water than the preceding carbonates; for it requires eight parts of cold water to dissolve it. The solution, by exposure to the air, loses part of its carbonic acid, especially if it be heated.

Characteristics. — It is distinguished from the before-mentioned carbonates by having scarcely any ammoniacal odour. Its solution at first occasions no precipitate with chloride of barium or chloride of calcium (unless caustic ammonia be added): after a short time, however, the mixture evolves carbonic acid, and a white earthy carbonate is precipitated.

Composition.—The composition of this salt is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Phillips.*	*Rose.*
Ammonia	1	17	21·5	21·16	21·39
Carbonic Acid	2	44	55·7	55·50	56·09
Water	2	18	22·8	23·34	22·52
Crystallized Bicarbonate of Ammonia	1	79	100·0	100·00	100·00

	Vols.
Ammoniacal gas	2
Carbonic Acid gas	2
Aqueous Vapour	2

Physiological Effects and Uses.—The operation and uses of this salt are analogous to those of the preceding compounds of ammonia. It is termed diaphoretic, antispasmodic, and antacid. Being less caustic, it is more palatable than the other carbonates. It may be employed to form effervescing medicines. About 18 grs. of Citric, or 19 grs. of Tartaric Acid, are required to saturate ℈j. of this salt.

Administration.—The dose of it is from six to twenty-four grains, dissolved in *cold* water.

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[a] See Rose's paper, in Taylor's *Scientific Memoirs*, vol. ii.

10. AMMO'NIÆ HYDROCHLO'RAS, *L.*—HYDROCHLORATE OF AMMONIA, *E.*

(Ammoniæ Murias, *E.D.*)

History.—The early history of this salt is involved in considerable obscurity; for though the term *sal ammoniacus* (ἅλς ἀμμωνίκος) is met with in several old writers, it is believed, by the erudite Beckmann[b] as well as by others, to refer to rock-salt. The first distinct notice of hydrochlorate of ammonia is to be met with in Geber, who was acquainted with the mode of purifying it by sublimation. But as my friend Dr. Royle observes[c], this salt "must have been familiar to the Hindoos ever since they have burnt bricks, as they now do, with the manure of animals; as some may usually be found crystallized at the unburnt extremity of the kiln."

The substance, whatever its nature may be, which the ancients termed sal ammoniac, derived its name from *Ammonia,* the name of a district of Libya where the oracle of Jupiter Ammon was situated. This district took its name from ἄμμος, *sand,* on account of the sandy nature of its soil. Herodotus[d] mentions the salt found in this district.

Synonymes.—Few substances have had so many synonymes as this salt. Besides those above given, the most familiar are, *sal ammoniac* or *muriate of ammonia.* On the ammonium hypothesis it is called *chloride of ammonium* (NH^4, Cl.), while, according to Dr. Kane, it is *chloro-amidide of hydrogen* (NH^2, H, H Cl.)[e]

Natural History.—(See *Ammonia,* p. 294.)

Preparation.—In Egypt, Sal Ammoniac is obtained by sublimation from the soot afforded by the combustion of camel's dung[f].

It is probable that the muriatic acid or chlorine of this salt is derived from the common salt on which these animals feed; for Chaptal[g] says that he could only procure sal ammoniac from the soot of cow-dung and that of horses while these animals continued to live on marine plants.

Some years ago this salt was manufactured in London from the soot of coals. At the latter end of the last century it was made in Paris by the union of ammoniacal vapour (obtained by the decomposition of animal matters, in iron cylinders placed in a furnace) with muriatic acid gas[h].

At the present time sal ammoniac is manufactured in this country from the impure ammoniacal liquors obtained as secondary products in the manufacture of coal gas and animal charcoal.

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[b] *History of Inventions,* vol. iv. p. 306. Lond. 1814.

[c] *Essay on the Antiquity of Hindoo Medicine,* p. 41. London, 1837.

[d] Lib. iv. [*Melpomene*], cap. 181 et 182.

[e] For the alchymical names of this substance, see Dr. T. Thomson's *History of Chemistry,* vol. i. p. 125. Lond. 1830; and Parr's *Medical Dictionary,* art. *Ammoniacus.*

[f] A very full and complete description of the process, with illustrative plates, will be found in the splendid *Description de l'Egypte,* Etat Moderne, tom. i. p. 413. Paris, 1809; Planches ii. & xxiv. Arts et Métiers. See also Parkes's *Chemical Essays,* ed. 2nd, vol. ii. p. 437. Lond. 1823.

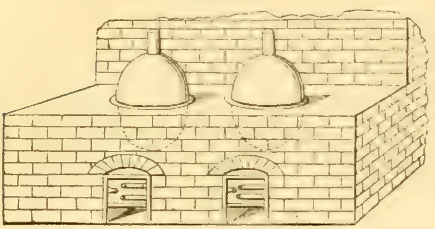
[g] *Elements of Chemistry,* vol. i. p. 262. Lond. 1791.

[h] See *Journal de Physique* for 1794.—Also Parkes, *op. supra cit.*

1. Manufacture of Sal Ammoniac from Coals.—In the manufacture of coal gas, coal is submitted to distillation in iron retorts, and the volatile matters obtained are conveyed to a condensing vessel or refrigeratory, in which are deposited tar and an ammoniacal liquor.

This ammoniacal liquor (commonly termed *gas liquor*) contains several salts of ammonia—such as carbonate, hydrocyanate, sulphate, and hydrosulphate. It is usually sold to sal-ammoniac manufacturers, who reside in the outskirts of the metropolis. The precise mode of proceeding, to convert it into sal ammoniac, varies according to circumstances. Sometimes sulphuric acid is added, and the liquor evaporated, by which brown crystals of sulphate of ammonia are obtained. This salt is then mixed with chloride of sodium, and submitted to distillation in iron pots lined with clay, to which is adapted a leaden dome or head, having an aperture or open cylindrical tube, which can be closed or opened according to circumstances (fig. 55).

Fig. 55.



Sublimation of Hydrochlorate of Ammonia.

A few years since I saw this process in operation at the Westminster Gas-works. On examining the clay removed from the pots after the operation, I discovered small, but perfect and beautiful, crystals of the bisulphuret of iron, which had been formed during the process.

Every equivalent or 66 parts of sulphate of ammonia react on one equivalent or 60 parts of chloride of sodium, and yield one equivalent or 54 parts of sal ammoniac, and one equivalent or 72 parts of sulphate of soda.

MATERIALS.		COMPOSITION.		PRODUCTS.
1 eq. Sulphate of Ammonia ..	66	*1 eq. Ammonia*	17	1 eq. Hydrochlor. Ammonia 54
		1 eq. Sulphuric Acid	40	
		1 eq. Water 9 { *1 eq. Hydrog.*	1	
		1 eq. Oxygen	8	
1 eq. Chloride of Sodium ..	60	*1 eq. Chlorine*	36	
		1 eq. Sodium	24	1 eq. Sulphate Soda 72
	126		126	126

In some cases the gas liquor is saturated with hydrochloric acid, and the brown crystals of hydrochlorate of ammonia obtained by evaporation are purified by sublimation.

As a cheap substitute for hydrochloric acid, manufacturers sometimes employ chloride of calcium[1]. This proceeding I have seen adopted at the manufactory of Messrs. Bush & Co., Bow Common.

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[1] The chloride of calcium used in the above process is a secondary product obtained, I am informed, from salt-works. It contains the chlorides of sodium and magnesium.

The process has been described by my friend and former pupil, Dr. G. H. Jackson[j].

To the gas liquor, chloride of calcium is added, when a copious precipitation of carbonate of lime takes place, muriate of ammonia being left in solution. The whole of this is put into a tub, having holes in the bottom to allow the solution to drain through, leaving the solid particles behind. This solution is evaporated at a gentle temperature in iron tanks, when it yields impure crystals of muriate of ammonia, of a brownish colour. The salt is then dried, and the water of crystallization driven off in a long iron vessel, very similar to a sand-bath. It is now placed in an iron subliming pot (previously coated to the extent of from one to five inches in thickness, with a composition of common clay, sand, and charcoal), capable of holding about 5 cwts. This is covered by a dome of lead, with an aperture at the top, in which a stopper is placed, by the removal and appearance of which the manufacturer judges of the progress of the sublimation. A gentle fire is kept up under the subliming pot for seven or eight days, when the dome having cooled down, and the sal ammoniac somewhat contracted, so as to loosen from the sides, the dome is thrown off from the iron pot, and about 2 or 3 cwts. of white, semi-transparent, muriate of ammonia are knocked off in cakes.

I have seen cakes of sal ammoniac, made at Messrs. Bush & Co.'s by this process, weighing between 5 and 6 cwts. each; and I am informed that they sometimes weigh 1000 lbs. each. They are discoloured on their convex surface (in contact with the leaden dome), and are, therefore, carefully scraped before being sent out.

The grey salt scraped from the exterior of the cakes consists of, or at least yields, hydrochloric acid, ammonia, and lead. A solution of the purified salt yields no iodide of lead on the addition of iodide of potassium, but affords a black precipitate (sulphuret of lead) when sulphuretted hydrogen gas is passed through it. It is probably a double chloride of lead and ammonium[k].

Yellow or brownish streaks or bands are frequently observed in the cakes of sal ammoniac. These are ascribed by the manufacturers to the neglect of the workmen who, falling asleep during the night, allow the fire to go down considerably, and then suddenly raise the heat, by which chloride of iron is sublimed in combination with sal ammoniac.

For several years I have been accustomed to show, in the lecture-room, that a solution of these yellow bands in water gives no traces of iron on the addition of ferrocyanide of potassium, until a few drops of nitric acid be added, when a copious blue precipitate is formed; and I, therefore, inferred that this yellow matter was a double chloride of iron and ammonium. My opinion has been fully confirmed by the experiments of Dr. G. H. Jackson.

2. Manufacture of Sal Ammoniac from Bones.—Animal charcoal is extensively manufactured from bones for the use of sugar-refiners; and during the process an ammoniacal liquor (called *bone spirit*) is obtained as a secondary product. The operation is thus conducted.

Bones are first boiled to remove the fatty matter which is used in soap-making. The larger and finer pieces are then selected for the manufacture of buttons, handles of knives and tooth-brushes, &c.; while the smaller and refuse portions are sold as manure. The remainder is submitted to distillation.

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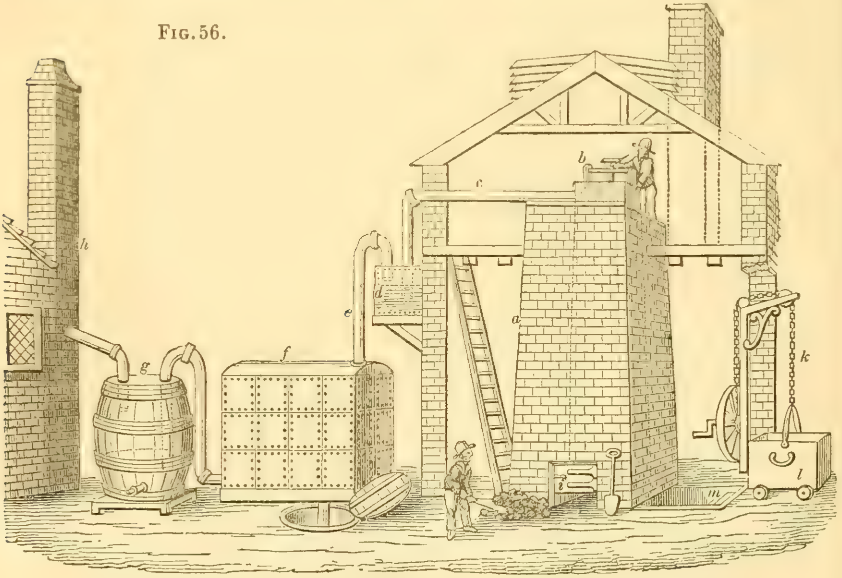
[j] *London Medical Gazette*, Aug. 4, 1839.
[k] Dr. Jackson, *Ibid.*

The stills or retorts are sometimes made of cast iron, and in shape and size resemble those used at gas-works. Formerly they were placed horizontally in the furnace[1], and the volatile matters were conveyed away by a pipe opening into the ends of the retorts. To facilitate the speedy removal of the charcoal, they are sometimes placed obliquely in the furnace: the bones are introduced at the upper end, and the charcoal is removed from the lower end;—while the volatile matters are conveyed away by a side pipe. But these retorts are considered inferior to the vertical ones, on account of the facility and speed with which the latter can be charged and discharged. The vertical stills or retorts are made of cast iron or of Welch bricks; the latter, I am informed, are preferable. In a large manufactory of animal charcoal in this metropolis, the shape of the retort is that of a right rectangular prism; its height being twenty feet, its length about three feet, and its breadth two feet. It is closed at the top by a moveable iron plate, secured by a screw bolt. It is closed below by a double trapdoor opening underground. Around the retort is a furnace of brickwork, whose shape is that of a truncated pyramid.

FIG. 56.



Manufactory of Animal Charcoal and Bone Spirit.

a. Furnace enclosing the retort.
b. Top of the retort.
c. Pipe to convey away the volatile products.
d. Water cistern, through which the volatile matter passes.
e. Pipe leading to
f. The iron receiver (an old steam boiler) communicating with a reservoir cistern underground.
g. Second receiver.
h. Chimney into which the residual vapour passes.
i. Furnace door.
k. Crane.
l. Canister to receive the charcoal.
m. Steps leading to the lower end of the retort.

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[1] See Ure's *Dictionary of Arts and Manufactures*, p. 1081, figs. 954 and 955. Lond. 1839.

The bones are introduced at the upper end of the retort (*b*). The volatile products are conveyed away by the iron pipe (*c*). After passing through the cistern (*d*) they are conveyed to a series of receivers (*f* and *g*), where the brown ammoniacal liquor (*bone spirit*) and the empyreumatic oil (*animal oil*) are deposited. The non-condensable portion is a fetid inflammable gas: this, after passing through water contained in the second receiver, is conveyed into a chimney, or is burned. The solid residue in the retort is removed, while red hot, through the lower and underground end of the retort, into wrought-iron canisters (*l*), which are instantly closed by iron covers, luted to make them air-tight, and then raised to the surface by a crane (*k*). When cold it is ground, and sold as *animal*, *bone*, or *ivory black*.

The products of this operation are easily accounted for. When bones are heated, their cartilaginous or gelatinous portion undergoes decomposition, and its elements (carbon, hydrogen, nitrogen, and oxygen) enter into new combinations. Some of the oxygen and hydrogen unite to form *water*. Carbon and oxygen, combining in different proportions, furnish *carbonic oxide* and *acid*. Carbon with hydrogen forms *carbohydrogen*; while nitrogen uniting with hydrogen produces *ammonia*, which, with some carbonic acid, forms *carbonate of ammonia*. The *empyreumatic* or *animal oil* consists of carbon, hydrogen, and oxygen, with probably some nitrogen.

Manufacturers of animal charcoal usually sell their bone spirit to makers of sal ammoniac, who adopt different modes of proceeding, according to circumstances. Sometimes sal ammoniac is made from bone spirit in the same way as from gas liquor. Some manufacturers digest the bone spirit with ground plaster of Paris (sulphate of lime), by which carbonate of lime and sulphate of ammonia are formed; the former is precipitated, the latter remains in solution. The liquor being filtered and evaporated yields brown crystals of sulphate of ammonia, which, being mixed with common salt, is submitted to sublimation, by which sulphate of soda and sal ammoniac are obtained.

PROPERTIES.—Hydrochlorate of ammonia usually occurs in commerce in the form of large hemispherical cakes, which are translucent, and by exposure to the atmosphere become slightly moist. By solution or sublimation it may be obtained in regular octohedral, or cubic, or plumose crystals: the latter are formed of rows of minute octohedrons, attached by their extremities (Graham). Its sp. gr. is 1·450. Its taste is saline and acrid; it has no odour. When heated, it sublimes without undergoing fusion or decomposition. It is soluble in about 3 parts of cold and 1 of boiling: cold being produced during the solution. It dissolves in alcohol.

Characteristics.—It may be recognised by the following characters: it is white and volatile; and if heated on the point of a knife by the flame of a candle, it readily sublimes. Mixed with caustic potash, or quicklime, it evolves ammoniacal gas, which is known by its odour, its action on turmeric paper, and its fuming with the vapour of hydrochloric acid. Dissolved in water the hydrochlorate of ammonia produces, with a solution of nitrate of silver, a white precipitate of chloride of silver, recognised by the properties before described (see

p. 226): and with bichloride of platinum a yellow precipitate (*platino-bichloride of ammonia*) which, when collected, dried, and ignited, yields spongy platinum.

COMPOSITION.—The following is the composition of this salt:—

	Atoms	*Eq.wt.*	*Per Ct.*	*Kirwan.*	*Bucholz.*	*Berzel.*
Ammonia	1	17	31·48	25	31	31·95
Hydrochloric Acid	1	37	68·51	75	69	68·05
Hydrochlorate Amm.	1	54	100·00	100	100	100·00

	Vol.	*Sp. gr.*
Ammoniacal gas	2	0·59027
Hydrochloric Acid gas	2	1·28472

1 eq. Ammonia = 17	1 eq. Hydrochl. Acid = 37

If one equivalent or two volumes of hydrochloric acid gas be mixed with one equivalent or two volumes of ammoniacal gas, combination is effected; the gases disappear, heat is evolved, and the white hydrochlorate is deposited.

Analogy would lead us to regard this salt as a chloride of some metallic base. If such a base exist, it must consist of one equivalent nitrogen and four equivalents hydrogen. Berzelius assumes the existence of this hypothetical metallic base, and calls it *ammonium*, while sal ammoniac is termed by him *chloride of ammonium*. The protoxide of this hypothetical metal will be equal to an equivalent of ammonia and one of water. I have already referred to Dr. Kane's amidogen hypothesis of ammonia; and stated that, according to this view, sal ammoniac is a *chloro-amidide of hydrogen*. The composition of sal ammoniac, according to these hypothetical notions, is as follows:—

	Atoms.	*Eq.Wt.*	*Per Ct.*
Chlorine	1	36	$66{\cdot}\dot{6}$
Ammonium	1	18	$53{\cdot}\dot{3}$
Chloride of Ammonium	1	54	$99{\cdot}\dot{9}$

	Atoms.	*Eq.Wt.*	*Per Ct.*
Chloride of Hydrogen	1	37	31·48
Amidide of Hydrogen	1	17	68·51
Chloro-amidide of Hydrogen	1	54	100·00

IMPURITIES. — The hydrochlorate of ammonia is sometimes rendered impure by the presence of iron, or of lead (see p. 317).

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—According to Sir H. Davy [m], water holding in solution 1·300 of its weight of hydrochlorate of ammonia promotes vegetation. Solutions which contained 1·30 of their weight of this salt he found injurious.

β. On Animals. — A solution of sal ammoniac mixed with the blood drawn from the body produces no change in the size or shape of the blood-disks. Courten [n], Sprögel, Viborg, and Gaspard (quoted by Wibmer) [o], injected solutions of sal ammoniac into the veins of animals (dogs and horses): large doses generally caused convulsions, sometimes paralysis, and death. From the observations of Orfila, Smith, Arnold [p], and Moiroud [q], this salt appears to be a local irritant, and when introduced into the stomach in large quantities causes vomiting, purging, and gastro-enteritis. It exercises a specific influence over distant organs, for the three first of the above-mentioned experimenters observed that inflammation of the stomach ensued, to whatever part of the body the salt might have been applied, and the convulsions and paralysis before referred to, attest its action on the nervous system. Arnold says it diminishes the plasticity of the blood.

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[m] *Agricultural Chemistry.*

[n] *Phil Trans.* for 1712.

[o] *Die Wirkung*, &c.

[p] Wibmer, *Op. cit.*

[q] *Pharmacol. Vétérinaire.*

γ. *On Man.*—Wibmer tried this salt on himself. He took from ten to twenty grains for a dose, which he repeated at the end of an hour. The effects were a sensation of warmth and oppression in the stomach, headache, and increased desire of passing the urine.

In this country it is so rarely employed internally that we have very slight experience either of its physiological or of its therapeutical effects. In Germany, where it is more frequently administered, it is in high repute as a powerful alterative or resolvent[r]. "Like most salts," says Sundelin[s], "sal ammoniac operates on the alimentary canal as an excito-irritant. After its absorption it appears to reduce moderately the action of the heart and large arteries, and, in this respect, belongs to debilitating or temperant agents. But it acts as excitant and irritant to the venous and arterial capillary systems, to the lymphatic vessels and glands, to the skin, to the kidneys, and especially to the mucous membranes; not only increasing secretion but also improving nutrition and assimilation, and counteracting organic abnormal conditions (as tumours, thickenings, and relaxations), so frequently met with in those structures. It promotes not only the mucous secretions but also cutaneous exhalation, and even menstruation. Its diuretic effects are less obvious. It extends its stimulating influence to the serous and fibrous tissues, whose nutrition it improves.

"From these statements it follows that sal ammoniac operates like the more-profoundly-acting alterative agents, and even approaches, in many respects, mercury, but is especially distinguished from the latter in this, that it by no means acts to such a degree as a liquefacient, nay even melting, agent on solidified organic substance and its crasis, and by its not so powerfully stimulating the lymphatic system. Its long-continued use may, indeed, injure the digestive powers, but never gives rise to general cachexia. I have administered large doses of it against thickening of the mucous membrane, for months, without remarking any injurious effects beyond those just mentioned. In large doses it purges like other salts, but in small ones rather constipates."

Kraus[t] says, that a slight miliary eruption and very painful aphthæ have been produced by large doses of it.

Uses.—In this country it is rarely employed internally. In Germany, where it is frequently used, it is administered in the following cases:—

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[r] See p. 195.

[s] *Handbuch der speciellen Heilmittellehre*, 1er Bd. S. 150, 3te Aufl.

[t] *Heilmittellehre*, S. 309. Göttingen, 1831.

1. *In mild inflammatory fevers*, especially these complicated with affections of the mucous or fibrous membranes, as in the diseases called bilious, gastric, catarrhal, or rheumatic fevers, it is employed for promoting secretion and hastening critical discharges.

2. *In inflammation of the mucous or serous membranes*, as catarrh, dysentery, urethritis, peritonitis, pleuritis, &c. when the first violence of the disease has been subdued, but when the secretions and exhalations are not yet established. In these cases it is used as a substitute for mercury.

3. *In chronic diseases* of various kinds, as chronic inflammation of the lungs, liver, and spleen — enlargement of the mesenteric glands—induration of the prostate, uterus, and ovaries—catarrhus vesicæ—chronic ulceration of the uterus—mucous discharges from the urethra and vagina, it is administered as an alterative, as a stimulant to the absorbent system, and as a promoter of healthy secretion.

4. *In amenorrhœa* it is strongly recommended by Sundelin[u] as an emmenagogue, in those cases in which the disease depends on, or is connected with, inactivity of the uterus.

Externally it is sometimes employed, on account of the cold produced during its solution, in headache, inflammatory affections of the brain, mania, apoplexy, &c. When used for this purpose it must be applied as soon as the salt is dissolved. Mr. Walker[v] found that five parts of this salt, with five parts of nitrate of potash and sixteen parts of water, lowered the thermometer from 50° to 10° F. A mixture of this kind placed in a bladder has been recommended by Sir A. Cooper as an application to hernial tumours, as I have already mentioned (see p. 33). It may be applied, instead of the ice-cap before noticed (p. 33), to the head.

As a stimulant and resolvent, or discutient, sal ammoniac is used in the form of *plaster* or *lotion* (see below). In powder it is sometimes employed as a dentifrice. A solution of ℥ss. in f℥xij. of water is sometimes used as a gargle.

It is occasionally used to augment the solubility of bichloride of mercury, with which it combines to form a soluble double salt (see *Liquor Hydrargyri Bichloridi*). Tobacconists use it in the manufacture of snuff.

Administration.—For internal use the dose of it is from five to thirty grains every two or three hours, either in a pulverulent form, combined with sugar or gum, or in solution with some saccharine or mucilaginous solution, to which an aromatic should be added.

Antidote.—In the event of poisoning by this salt, warm water and mucilaginous and demulcent liquids should be given, to promote vomiting. No chemical antidote or counterpoison is known. Gastroenteritis is, of course, to be combated by the usual means.

1. LOTIO AMMONIÆ HYDROCHLORATIS. *Muriate of Ammonia Wash.—*

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[u] *Op. cit.*

[v] *Phil. Trans.* 1801, p. 120.

A solution of sal ammoniac, in water or in vinegar, with or without the addition of rectified spirit, is used as a resolvent or discutient lotion or embrocation. The proportions of the ingredients vary according to circumstances. When a strong lotion is required, from one to two ounces of the salt are dissolved in twelve fluidounces of liquid. Four ounces of rectified spirit are sometimes added. A wash of this strength is used in contusions and ecchymosis, when there is no wound of the skin;—in chronic tumors of the breast;—in white swellings, and other chronic affections of the joints;—in hydrocele, and dropsical enlargement of the thyroid gland;—in chilblains;—in sphacelus, after the requisite scarifications, &c. Weaker solutions (as from ʒj. to ʒiv. of the salt in Oj. of water) are employed as washes in scabies and ulcers; and as injections in gonorrhœa and leucorrhœa.

2. **EMPLASTRUM AMMONIÆ HYDROCHLORATIS.** *Sal Ammoniac Plaster.* Lead plaster ℥ss., Soap ʒij.; melt them together, and when nearly cold, add Hydrochlorate of Ammonia ʒss., in fine powder.—This plaster is stimulant and rubefacient. Its efficacy depends on the evolution of ammoniacal gas, in consequence of the action of the alkali of the soap on the hydrochloric acid of the sal ammoniac: hence it requires renewal every twenty-four hours. It is employed as a discutient for chronic swellings and indurations, white swellings, &c. Dr. Paris[w] recommends it in rheumatism of the muscles of the chest, and in pulmonary complaints.

11. LI'QUOR AMMO'NIÆ ACETA'TIS, *L.*—SOLUTION OF ACETATE OF AMMONIA.

(Ammoniæ Acetatis Aqua, *E. D.*)

History.—This solution appears to have been first described in 1732, by Boerhaave, who introduced it into the Materia Medica. It was subsequently employed by Minderer or Mindererus; and hence obtained one of its names, *Spiritus* seu *Liquor Mindereri.*

Natural History.—Acetate of ammonia is, I believe, always an artificial compound.

Preparation.—The *London College* directs this solution to be prepared with Sesquicarbonate of Ammonia ℥ivss., or as much as may be sufficient, and Distilled Vinegar Oiv.; add the Sesquicarbonate of Ammonia to the Vinegar to saturation.

The *Edinburgh College* orders "Distilled Vinegar (from French Vinegar in preference) f℥xxiv.; Carbonate [Sesqui] of Ammonia ℥j.: mix them to dissolve the salt. If the solution has any bitterness, add, by degrees, a little distilled vinegar till that taste be removed. The density of the distilled vinegar should be 1·005, and that of Aqua Acetatis Ammoniæ 1·011."—The *Dublin College* directs one part of [Sesqui] Carbonate of Ammonia to be added gradually, and with frequent agitation, to as much distilled vinegar as may be requisite to saturate the ammonia; namely, about thirty parts. The saturation is to be determined by means of litmus.

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[w] *Pharmacologia.*

In practice, diluted acetic acid is frequently substituted for distilled vinegar; and as the per centage strength of this acid, as found in commerce, is subject to considerable variation, so must be the strength of the solution of acetate of ammonia. To obviate this, it would have been better if the British Colleges had fixed absolutely the quantity of hydrated sesquicarbonate of ammonia which should be employed to yield a given number of fluidounces of the solution of acetate of ammonia. Apothecaries then would be at liberty to employ a stronger or a weaker acetic acid, without affecting the strength of the product[x].

Every equivalent or 118 parts of hydrated sesquicarbonate of ammonia require two equivalents or 102 parts of anhydrous acetic acid to form a neutral compound, while three equivalents or 66 parts of carbonic acid gas are set free. Assuming distilled vinegar to contain 4·6 per cent. of real acid, it follows that 2217·39 parts of distilled vinegar would contain two equivalents or 102 parts of acetic acid.

MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Hydrated Sesquicarbonate of Ammonia ..	118	*3 eq. Carbonic Acid....*	66	3 eq. Carbonic Acid..	66
		2 eq. Water............	18	2 eq. Water..........	18
		2 eq. Ammonia	34		
2 eq. Acetic Acid.	102			2 eq. Acetate Ammon.	136
	220				220

Properties.—When pure this liquid is colourless. Any tint, therefore, which the solution of the shops may have, is referrible to impurities in either the vinegar or the sesquicarbonate. Filtering it through powdered animal charcoal will usually remove any yellow or brown colour which it may have. If quite neutral, it will affect neither turmeric nor litmus paper. It is better, however, to have a slight excess of acid present than of sesquicarbonate; for if the latter predominate, the solution is much more irritant; and if employed as a collyrium, might produce inconvenient results.

Characteristics.—It is totally dissipated by heat. With nitrate of silver it gives crystals (*acetate of silver*) soluble in water. When concentrated it evolves vapours of acetic acid on the addition of strong sulphuric acid, and gives out ammonia if potash or lime be mixed with it. With sesquichloride of iron it yields a red liquor (*peracetate of iron).*

Composition.—By evaporating a saturated solution of acetate of ammonia under the exhausted receiver of the air-pump, and over sulphuric acid, crystals of the acetate are obtained. They are transparent oblique rhomboidal prisms, and consist, according to Dr. Thomson, of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Acetic Acid....................	1	51	38·931
Ammonia	1	17	12·977
Water	7	63	48·091
Crystallized Acetate Ammonia..	1	131	99 999

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[x] For some remarks on the different strengths of this preparation in the different European pharmacopœias, see Mohr, in the *Berlinisches Jahrbuch für die Pharmacie,* Bd. xliii. S. 253. Berl. 1840.

The quantity of dry or anhydrous acetate of ammonia contained in the solution kept in the shops, varies with the strength of the distilled vinegar. Now, according to Mr. Phillips, 100 grs. of distilled vinegar should saturate 13 grains of crystallized carbonate of soda. This would indicate the presence of 4·6 per cent. of acetic acid; and, consequently, 100 grains of liquor ammoniæ acetatis, prepared from such vinegar, would be composed as follows:—

Acetate of Ammonia (dry)	6·040	Crystallised Acetate of Ammonia	11·635
Water	93·959	Water	88·364
Liquor Ammoniæ Acetatis (Ph. L.)	99·999	Liquor Ammoniæ Acetatis (Ph. L.)	99·999

Impurities.—This solution ought neither to be discoloured by the addition of hydrosulphuric acid, nor to throw down any precipitate by nitrate of silver or chloride of barium. These substances, therefore, may be employed to detect, respectively, metallic matter, hydrochloric acid or a chloride, and sulphuric acid. Pure acetate of ammonia occasions no precipitate with diacetate or acetate of lead; but the liquor ammoniæ acetatis of the shops usually does, owing to the presence of some free carbonic acid or sesquicarbonate of ammonia.

Physiological Effects.—In small doses this solution is regarded as a refrigerant: in large doses, diaphoretic, diuretic, and perhaps resolvent. These effects, however, are not very obvious. Wibmer[y] took it in moderate doses, yet did not observe any diaphoretic, diuretic, or purgative effects from it; but he experienced headache and disturbed digestion. Dr. Cullen[z] says, "I have known four ounces of it taken at once, and soon after four ounces more, without any sensible effect." The local operation of this solution is that of a mild stimulant.

Uses. *a. Internal.*—It is employed in febrile and inflammatory diseases, and forms a constituent of the ordinary saline draught. It is given in conjunction with nitrate of potash, or tartar emetic, and sometimes with camphor and opium. When administered as a diaphoretic, its operation is to be promoted by the use of tepid diluents and external warmth. Its diuretic effect is assisted by keeping the skin cool, and conjoining the spirit of nitric ether.

β. External.—Diluted with water it is sometimes employed as a discutient wash to inflamed and bruised parts. Mixed with six or seven times its volume of rose-water, to which a drachm or two of tincture of opium may sometimes be added, it is employed as a collyrium in chronic ophthalmia.

Administration.—It is given in doses of half a fluid ounce to two or three ounces every five or six hours.

OTHER SALTS OF AMMONIA.

1. AMMONIÆ SULPHAS; *Sulphate of Ammonia; Sulphate of Oxide of Ammonium; Oxysulphion of Ammonium; Glauber's Secret Sal Ammoniac.*—This salt is a constituent of soot from coals. It is usually obtained by dissolving hydrated sesquicarbonate of ammonia in diluted sulphuric acid to saturation, and evaporating so that crystals may form as the solution cools. In an impure state it is procured by saturating the ammoniacal liquor of gas works or bone spirit with sulphuric acid; and the sulphate thus obtained is used in the preparation of sal ammoniac. Sulphate of ammonia when crystallized (NH^3, SO^3, 2 HO) contains two equivalents of water; of one of which it may be deprived by heat. Anhydrous sulphate of ammonia does not appear to exist; for when anhydrous sulphuric acid and ammoniacal gas are combined, a compound is formed in which neither sulphuric acid nor ammonia are evident to the usual tests. Its composition is supposed to be $N\,H^2, SO^2 + HO$, and it has been denominated *sulfamide.*

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[y] *Die Wirkung*, &c.
[z] *Materia Medica.*

2. **AMMONIÆ NITRAS**; *Nitrate of Ammonia; Nitrate of Ammonium*; *Nitrum semivolatile; Nitrum flammans.* This salt is obtained by saturating diluted nitric acid with sesquicarbonate of ammonia, and evaporating so that crystals may form when the solution cools. If the solution be evaporated at a temperature below 100° F., large and beautiful six-sided prisms are obtained, terminated by six-sided pyramids (*prismatic nitrate of ammonia*). These crystals belong to the right prismatic system, and are isomorphous with nitrate of potash. They consist of one equivalent nitric acid 54, one equivalent ammonia 17, and one equivalent water 9. If the solution be boiled down, fibrous crystals are obtained (*fibrous nitrate of ammonia.*) When dried at 300° F. nitrate of ammonia assumes the form of a compact white mass (*compact nitrate of ammonia*). In doses not exceeding a scruple, this salt acts as a diuretic; and, according to the experiments of Wibmer[a] made on himself, it reduces the frequency of the pulse and the animal heat, without affecting the head, chest, or stomach. It has been given in fevers and acute catarrhs, in doses of from one to two scruples. But it is rarely employed.

It is the source from whence *protoxide of nitrogen* is obtained (see p. 283). As it generates considerable cold while dissolving in water, it is sometimes used to form a freezing mixture. Lastly, it is occasionally employed to promote the incineration of organic substances.

3. **AMMONIÆ CITRAS**; *Citrate of Ammonia.*—A solution of this salt is obtained by saturating lemon or lime juice, or a solution of citric acid, with sesquicarbonate of ammonia. 70 grains of the commercial crystals of citric acid, or f℥xvijss. of lemon juice, saturate 59 grains of hydrated sesquicarbonate of ammonia. Liquid citrate of ammonia is employed either in the still or effervescent form as a cooling saline diaphoretic in febrile disorders.

ORDER VII.—CARBON, AND ITS COMPOUNDS WITH OXYGEN, HYDROGEN, AND NITROGEN.

SECT. I.—CARBONIUM.—CARBON.

HISTORY.—The term *carbon* (from *carbo, ōnis*, coal) was first employed by Morveau, Lavoisier, and Berthollet, to designate the pure matter of charcoal. To the second of these chemists, we are indebted for demonstrating, that by combustion in oxygen gas the diamond and charcoal yield the same product; namely, carbonic acid gas.

NATURAL HISTORY.—Carbon is found in both kingdoms of nature:

α. *In the Inorganised Kingdom.*—When pure and crystallized it constitutes the diamond, which Sir D. Brewster[b] suspects to be of vegetable origin; but a specimen, described by Mr. Heuland[c], was found in a primary rock. Plumbago and anthracite consist principally of carbon. The bituminous substances (as coal, petroleum, naphtha, &c.) also contain it. These are admitted by geologists to be of vegetable origin. Carburetted hydrogen is evolved from coal strata, marshy places, stagnant waters, &c. Carbonic acid is found either in the free state, as in the atmosphere, in mineral waters evolved from the earth in old volcanic countries, &c. or combined with metallic oxides, in the form of the carbonate of lime, iron, &c. It is remarkable that carbon is rare among the older rocks [d].

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[a] *Die Wirkung der Arznemittel und Gifte*, Bd. 1, S. 130. München, 1831.
[b] *Edinburgh Philosophical Journal*, vol. iii. p. 98; and *Philosophical Magazine*, vol. i. p. 147. 1827.
[c] *Geological Transactions*, 2d Series, i. 419.

β. In the Organised Kingdom.—Carbon is an essential constituent of all organised beings, vegetable or animal.

PROPERTIES.—Carbon is a solid, odourless, tasteless substance, neither fusible (?) nor volatile: combustible in oxygen gas, yielding carbonic acid gas. Its equivalent by weight is 6. Some years since Dobereiner asserted that he had discovered a metallic basis in it; but this statement has not been confirmed.

The other properties of carbon are so varied, that chemists are obliged to admit distinct varieties of this substance: the principal are the *diamond*, *plumbago*, and *charcoal* (animal and vegetable). Of these the two latter only require consideration in this work.

1. PLUMBAGO.—GRAPHITE OR BLACK LEAD.

HISTORY.—This substance was probably known to the ancients; but it was first accurately distinguished from other bodies with which it had been previously confounded, especially with molybdena (*bisulphide of molybdenum*), by Scheele [e], in 1779. The terms *plumbago*, *plumbum nigrum*, *molybdæna*, met with in Pliny [f], do not apply to graphite.

NATURAL HISTORY.—It is found in various parts of the world; chiefly in primitive rocks and the coal formations. The finest occurs at Borrowdale, in Cumberland. It is brought to London, and sold by auction, at a public-house in Essex-street, Strand, on the first Monday in every month [g]. The best quality usually sells for two guineas or more per pound, and is employed for making pencils. The ordinary kinds used in this country are imported from Ceylon and Hamburgh.

PROPERTIES.—It occurs either crystallized in regular six-sided prisms (belonging to the rhombohedric system), or in kidney-shaped masses, or disseminated in rocks. Its colour is iron or steel-grey, with a metallic lustre. It has a greasy feel, and writes easily on paper. Its specific gravity is 2·08 to 2·45.

Characteristics.—It is known to be a variety of carbon by its yielding carbonic acid when burned in oxygen gas. Its physical properties distinguish it from most other varieties of this element. Some kinds of coal-gas charcoal closely resemble it. Of non-carbonaceous substances, molybdena (*bisulphide of molybdenum*) is the only substance that can be confounded with it in external appearance.

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[d] De la Beche, *Researches in Theoretical Geology*, p. 32. Lond. 1834.

[e] *Essays*, p. 246.

[f] *Historia Naturalis*, lib. xxxiv. cap. 47, 50, and 53, ed. Valp.

[g] *London Medical Gazette*, vol. xviii. p. 267.

Composition.—It consists essentially of *carbon*, but is usually mixed with variable proportions of silica, iron, and other substances. The following are analyses of three varieties by Vanuxen[h]:—

	Borrowdale. (*pure.*)	*Borrowdale.* (*impure.*)	*Bustletown.* (*pure.*)
Carbon	88·37	61·27	95·4
Water	1·23	5·33	0·6
Silica	5·10	10·10	2·6
Alumina	1·00	3·20	0·0
Oxides of Iron, Manganese, &c.	3·60	20·00	1·4
Plumbago	99·30	99·90	100·0

I suspect, however, that the finest varieties of the Borrowdale graphite contain a less quantity of foreign matter than is here stated. Graphite has been recently analysed by Dr. R. F. Marchand[i], who states that 1·4580 *gramme* of native graphite left a residue of pure white silica, without a hue of oxide of iron, weighing only 0·0075. On the erroneous supposition that the carbon was chemically combined with iron, graphite was formerly called *carburet* or *percarburet of iron.* From some observations of Schrader's, however, it would appear that the iron is in combination with titanic acid.

Physiological Effects.—Various properties have been assigned to it; but further evidence is wanting to establish its action on the body. Richter[j] says it alters, in some way, the lymphatic secretion and the condition of the skin; and, after some days' use, causes increased secretion of urine, with difficulty in passing it.

Uses.—It has been employed both externally and internally in chronic diseases of the skin (as herpes). When used externally, it is mixed with lard in the proportion of one or two drachms to an ounce of the latter. Internally the dose is ten or twelve grains to a drachm.

2. CAR'BO LIG'NI, *L. E. D.*—WOOD CHARCOAL.

History.—Wood charcoal must have been familiar to man from the most remote period of antiquity, and was probably known to the first inhabitants of the globe. For an account of the ancient method of procuring it, I must refer the reader to the works of Theophrastus (cap. x.) and Pliny[k].

Natural History.—Wood charcoal is always an artificial product. Some samples of Bovey coal have very much the appearance of wood charcoal, but are readily distinguished by their containing hydrogen, in consequence of which they burn with a yellow flame. Moreover, they are not good conductors of galvanic electricity[l].

Preparation.—Ordinary wood charcoal is prepared, on the large scale, for the purposes of fuel, by burning billet-wood piled in a conical heap, covered by turf and sand, to prevent the access of atmospheric air, a few holes being left near the bottom and one at the top, to occasion a draught. The heap is then set fire to, and when the flame has pervaded the whole mass, the holes are closed. When cooled, the billets are found converted into charcoal. For an account of the mode of arranging the wood in heaps, consult Dumas [m].

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[h] Silliman's *Journal*, vol. x. p. 105.

[i] *Proceedings of the Chemical Society*, No. 1, p. xii. 1841.

[j] *Ausführliche Arzneimittellehre*, 3er Bd. p. 486. Berlin, 1828.

[k] *Hist. Nat.* lib. xvi. cap. vii.

[l] Kidd's *Outlines of Mineralogy*, vol. ii. p. 47.

The charcoal used in the manufacture of gunpowder is prepared by the distillation of wood in cast iron cylinders, set horizontally (or nearly so) in brickwork, over a furnace. The charge is introduced at the front, and the opening is then perfectly secured by an iron door and bar, well luted. The back part of each cylinder is perforated by two pipes, one above the other, which bend downwards into tubs containing water. The tar flows out by the lower pipe, and the pyroligneous acid by the upper one, and condenses in the receiver (the tub). The smoke and vapours escape into the air. When sufficiently burnt, the charcoal is raked out into iron boxes, which are immediately covered, to exclude the air [n]. At the Waltham Abbey mills, charcoal is prepared from the Dogwood (*Cornus sanguinea*), the Alder (*Alnus glutinosa*), and the Willow (*Salix*). The Dogwood charcoal (which occasions a peculiar ringing sound when it falls on stones) is used for rifle powder: the other kinds for cannon and musket powder. Lieut.-Col. Moody tells me that the Dutch White Willow (*Salix Russelliana?*) is the best kind of Willow for charcoal, but that the Huntingdon Willow is also a good one. (See also *Acetic Acid.*)

PROPERTIES.—Wood charcoal is black, odourless, and insipid. It has the texture of the wood from which it has been obtained. It is brittle, and may be easily pulverized, especially when hot. Though a very bad conductor of heat, it is an excellent conductor of electricity. It is insoluble, infusible, and incapable of volatilization. Its specific gravity varies, according to the substance from which it has been obtained. A remarkable property possessed by it is that of abstracting certain substances (such as hydrosulphuric acid, organic colouring principles, various odorous matters, &c.) from liquids in which they are dissolved, or through which they are diffused. Another curious quality is that of condensing, within its pores, a certain quantity of any gas with which it may be placed in contact. One volume of boxwood charcoal absorbs 1·75 volumes only of hydrogen gas, but 90 volumes of ammoniacal gas. Some of the properties now mentioned (as that of decolorizing) are possessed, in a more eminent degree, by animal charcoal.

Characteristics.—By combustion in oxygen gas, charcoal yields carbonic acid gas; a property by which it is shown to consist of carbon. Its texture and appearance will distinguish it from other forms of carbon.

COMPOSITION.—The following is the composition of charcoal obtained from different woods, according to the experiments of Berthier [o]:—

	Poplar.	Maple.	Ash.	Fir.	Alder.	Birch.	Oak.	Hazel.
Carbon	85·6	85·2	83·2	90·3	90·2	88·1	88·0	87·7
Calcined Ashes	1·0	1·0	1·8	2·2	1·8	1·9	2·0	2·0
Volatile Matters	13·4	13·8	15·0	7·5	8·0	10·0	10·0	10·3
Charcoal	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

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[m] *Traité de Chimie appliqué aux Arts*, t. i. p. 561.

[n] For some further details consult Mr. Wilkinson's work on the *Engines of War*. Lond. 1841.

[o] *Traité des Essais par la voie sèche*, t. i. p. 286. Paris, 1834.

Physiological Effects.—Wood charcoal I believe to be an inert substance both with respect to animals and vegetables. Burdin[p] gave a pound of it daily without producing any other effect than that of blackening the stools. A variety of properties and virtues have, however, been ascribed to it, as I believe, without foundation: thus it has been termed anodyne, emmenagogue, tonic, purgative, &c. In the French edition of Hahnemann's Materia Medica[q], no less than thirty-five pages are occupied with the enumeration of the symptoms produced by one-millionth of a grain of this substance!!

Uses.—In this country, charcoal is used as a therapeutic agent, principally as a disinfectant and antiseptic, to absorb the fetid odour evolved by gangrenous and phagedenic ulcers. For this purpose it may be used in the form of powder or of poultice. Its disinfecting and antiseptic powers, however, are much inferior to those of chlorine, or of the chlorides [hypochlorites] of lime and soda.

As a *tooth-powder* it is a valuable agent, freeing the teeth from the foreign matters which cover them, and at the same time counteracting the unpleasant smell of the breath arising from decayed teeth or disordered stomach; but it is apt to lodge in the space between the gum and tooth, forming an unsightly livid circle (see p. 219). Brachet[r] states, that it checks caries of the teeth. Areca-nut charcoal is a favourite variety for tooth-powders.

Internally, charcoal has been exhibited in various affections of the alimentary canal, such as dyspepsia, cardialgia, diarrhœa, and dysentery. The beneficial effects said to have been produced in these cases can only be referred to the action of charcoal on the secretions of the bowels; an explanation apparently supported by Dr. Chapman's statement, that in dysentery, when the stools are highly acrid and offensive, charcoal entirely divests them of their bad smell and acrimony. In consequence of the advantage said to have been obtained by Dr. Calcagno, of Sicily, by the use of charcoal in intermittents, it was tried by Dr. Calvert, physician to the British forces at Palermo, and with success[s]. In this country, however, I believe, it is never resorted to in ague by medical practitioners. Dr. Daniel, of Savannah, has recommended it in obstinate constipation, and in the nausea and confinement of the bowels which frequently attend pregnancy. It has also been used in various other diseases, but experience has not confirmed its efficacy.

Administration.—The dose of charcoal, as ordered by different writers, varies from ten grains to a table-spoonful or more.

CATAPLASMA CARBONIS LIGNI, D. *Charcoal Poultice.* (Prepared by taking Wood Charcoal red hot from the fire, extinguishing it by sprinkling dry sand over it, reducing it to a very fine powder, and adding it to the simple cataplasm warm).—The *simple cataplasm* here referred to is made by adding boiling water to a mixture of one part linseed meal and two parts oatmeal, and smearing it over with olive oil. The charcoal poultice is applied to foul, unhealthy, and gangrenous ulcers, to destroy their fetor and improve their appearance. As an antiseptic, however, it is inferior to the chlorides [hypochlorites] of lime and soda.

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[p] *Dict. de Mat. Méd.* art. *Carbone*, t. ii., par MM. Mérat and De Lens.

[q] *Traité de Matière Médicale*, par S. Hahnemann; traduit par A. J. L. Jourdan. Paris, 1834.

[r] *Considérations sur l'Usage du Carbone en Médecine.* Paris, 1803.

[s] *Edinb. Med. and Surg. Jour.* vol. x. p. 15.

3. CAR'BO ANIMA'LIS, *L.E.*—ANIMAL CHARCOAL.

History and Synonymes.—This substance must have been known from the most ancient times. The kind usually met with in the shops is prepared from bones, and is termed *bone black*, or, more commonly, *ivory black* (*ebur ustum nigrum*).

Natural History.—It is always an artificial product.

Preparation.—The mode of preparing animal charcoal from bones has been already described. (See *Ammoniæ Hydrochloras*, p. 318.)

Properties.—In its general properties animal charcoal agrees with charcoal procured from wood. The decolorising powers of the former are, however, much superior to those of the latter.

Composition.—Animal charcoal, prepared by calcining the bones of the ox, sheep, and horse, consists of the following ingredients[ss]:—

Phosphate of Lime Carbonate of Lime	88·0
Charcoal	10·0
Carburet or Silicet of Iron	2·0
Sulphuret of Calcium or Iron	traces
Common Bone Black	100·0

For the ordinary purposes of the arts, as sugar refining, this impure animal charcoal answers very well, because the earthy salts in no way affect the process. But in various pharmaceutical operations the presence of phosphate and carbonate of lime would preclude its use, on account of the free acid in the liquids to be decolorised. Hence the necessity of the purification of animal charcoal.

Animal charcoal, when deprived of its saline matters, usually contains traces of nitrogen. Döbereiner, indeed, supposed it to be a kind of sub-nitruret of carbon, composed of one equivalent or 14 parts of nitrogen, and six equivalents or 36 parts of carbon. Bussy, however, has shown, that though animal charcoal retains its nitrogen with considerable obstinacy, yet that the latter may be separated by heat.

Physiological Effects.—The remarks already made in reference to the physiological effects of wood charcoal apply equally well to animal charcoal.

Uses.—The principal use of animal charcoal is as a decolorising agent in various pharmaceutical processes, as in the preparation of sulphate of quina, hydrochlorate of morphia, veratria, &c. The theory of its efficacy is imperfectly understood. The superior value of animal to vegetable charcoal is usually referred to the minute separation of the carbonaceous particles effected by the presence of other matters, as of phosphate of lime, when bones are employed. Carbonate of potash is better for this purpose than phosphate of lime. The property possessed by minute particles of charcoal, of abstracting colouring matter from liquids, depends, probably, on some chemical affinities existing between carbon and colouring matter. It is stated, in some works, that charcoal which has been once used cannot have its decolorising property restored by a fresh ignition, unless it be mixed with some inorganic substance. This, however, is an error. The animal charcoal which has been used in sugar refining, is returned to the maker to be fresh ignited, and is then employed again, and this process of re-igniting, is, I am informed, repeated many times, without any loss of decolorising power.

[ss] Dumas, *Traité de Chimie*, t. i. p. 450. Paris, 1828.

CARBO ANIMALIS PURIFICATUS, L. E. *Purified Animal Charcoal.* (Animal Charcoal, lbj.; Hydrochloric Acid [commercial, *E.*] and Water, of each, f℥xij. Mix the acid with the water, and pour it gradually upon the water; then digest for two days with a gentle heat, frequently shaking them. Set by, and pour off the supernatant liquor, then wash the charcoal very frequently with water, until nothing acid is perceptible; lastly, dry it. *L.*—The *Edinburgh College* directs the mixture to be boiled, after the digestion for two days; then diluted with two pints of water; the undissolved charcoal collected in a filter of linen and calico, and washed with water till what passes through scarcely precipitates with solution of carbonate of soda. The charcoal is to be heated first moderately, and then to redness in a closely covered crucible.)—In this process the hydrochloric acid dissolves the phosphate of lime, and decomposes the carbonate of lime and sulphuret of calcium, evolving carbonic and hydrosulphuric acid gases, and forming chloride of calcium, which remains in solution. The carbonate of soda, used by the Edinburgh College, is for the purpose of detecting the presence of a calcareous salt in the washings.

Purified animal charcoal causes no effervescence when mixed with hydrochloric acid, by which the absence of carbonate of lime is shown. Nor is any precipitate produced by the addition of ammonia, or its sesquicarbonate, to the acid which has been digested in the charcoal, by which the absence of any dissolved calcareous matter is shewn: caustic ammonia would precipitate any phosphate of lime in solution, while its sesquicarbonate would yield a white precipitate with chloride of calcium. Purified animal charcoal, "when incinerated with its own volume of red oxide of mercury, is dissipated, leaving only a scanty ash."—*Ph. Ed.*

Purified animal charcoal is used as a decolorising agent in the preparation of the vegetable alkaloids.

SECT. II.—OXYCARBONS.

1. AC´IDUM CARBON´ICUM.—CARBONIC ACID.

History and Synonymes.—Although the ancients were acquainted with the poisonous properties of carbonic acid gas, Dr. Black, in 1757, was the first who explained its nature. The *spiritus lethalis* of the ancients is evidently this acid, as is also the *spiritus sylvestris* or *gas* of Paracelsus and Van Helmont. *Fixed air*, *acid vapour*, and *aërial acid*, are other synonymes for it.

NATURAL HISTORY.—It is a constituent of both kingdoms of nature.

α. *In the Inorganised Kingdom.*—Carbonic acid is a constituent of the atmosphere. In some parts of the world it is evolved from the earth in large quantities, particularly in old volcanic countries. Thus, in the vicinity of the Lake of Laach, Bischof estimates the exhalation as equal to 600,000 lbs. daily, or 219,000,000 lbs. (equal to about 1,855,000,000 cubic feet) annually[t]! Some of the acid, evolved in the Brohlthal, on the Rhine, is employed by him in the manufacture of chemical preparations on the large scale. D'Arcet has applied the carbonic acid gas, evolved from the mineral waters of Vichy, to the preparation of alkaline bicarbonates[u]. Most persons are familiar, by report, with the *Grotto del Cane*, near Naples. It is a cavity in a rock, through the fissures of which carbonic acid is evolved. It has received its name from the practice of putting dogs into it, who fall down suffocated. The *Valley of Poison*, in Java, which has been described by Loudon, is another spot where this acid escapes from the earth. It is a cavity of an oval form, about three quarters of a mile in circumference, and from thirty to thirty-five feet deep; filled to the height of about eighteen feet with carbonic acid gas. The bottom of it is covered with the skeletons of men and various other animals, who have fallen victims to its destructive operation. If a traveller should be so unfortunate as to enter it, he cannot be sensible of his danger until too late to return. Mr. Loudon thrust a dog in: he fell in fourteen seconds. A fowl thrown in appeared to be dead before it reached the ground!!

Carbonic acid gas is frequently met with in mines and wells; and is termed by miners *choke damp* (from the German *dampf*, vapour).

Few mineral waters are without this acid; and in some it exists in such quantity, as to give them a sparkling or effervescent quality (see p. 268).

Lastly, carbonic acid is found (native) in combination with various bases: as with soda, baryta, strontian, lime, magnesia, and the oxides of manganese, zinc, lead, iron, and copper. According to Mr. De la Beche[v], the average amount of carbonic acid, locked up in every cubic yard of limestone, is about 16,000 cubic feet.

It is produced in the burning of limestone (carbonate of lime) at limekilns, and by the combustion of charcoal, coal, wood, coal gas, the fire-damp of coal-mines, and other combustibles containing carbon.

β. *In the Organised Kingdom.*—Carbonic acid gas is exhaled by plants in dark or shady places, and hence is met with in greenhouses, especially during the night. Animals develope it in the process of respiration; and, therefore, in crowded rooms, with imperfect ventilation, accidents have sometimes happened from the accumulated carbonic acid. It is produced by the decomposition of organic matters, as during the fermentation of saccharine fluids, and in the destructive distillation of animal substances: hence the danger of descending into brewers' vats. Free or combined carbonic acid is found in the blood, urine, bones, &c.

PREPARATION.—Carbonic acid gas may be procured in various ways, but for ordinary purposes is usually obtained by the action of some acid on carbonate of lime. Soda-water makers and the preparers of the alkaline bicarbonates obtain it by the action of sulphuric acid on common whiting. In the laboratory, hydrochloric acid and white marble are generally employed. It is most readily prepared in a tubulated glass retort, and may be collected over water. The ordinary hydrochloric acid of the shops should be diluted with four or five times its volume of water. By the reaction of one equivalent or 37 parts of hydrochloric acid on one equivalent or 50 parts of carbonate of lime, we obtain one equivalent or 56 parts of chloride of calcium, one equivalent or 9 parts of water, and one equivalent or 22 parts of carbonic acid.

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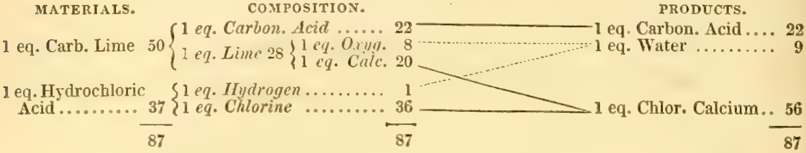
[t] De la Beche, *Theoret. Geology.*

[u] See the description and drawing of the apparatus used in the *Dictionnaire de l'Industrie, Manufacturier, Commerciale et Agricole,* t. iii. p. 60, art. *Carbonates.* Paris, 1835.

[v] *Op. cit.*


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Carb. Lime 50
1 eq. Carbon. Acid 22
1 eq. Lime 28
1 eq. Oxyg. 8
1 eq. Calc. 20
1 eq. Hydrochloric Acid.......... 37
1 eq. Hydrogen 1
1 eq. Chlorine 36
87
87
1 eq. Carbon. Acid.... 22
1 eq. Water 9
1 eq. Chlor. Calcium.. 56
87

Properties.—At ordinary temperatures and pressures, carbonic acid is gaseous. In this form it is invisible, irrespirable, has a faint odour, and a sharp taste. Its specific gravity is 1·5277. It is neither combustible nor a supporter of combustion, except in the case of potassium, which, when heated in this gas, takes fire, the products of the combustion being carbon and carbonate of potash. It extinguishes most burning bodies when introduced into it in the ignited condition. It reddens litmus feebly.

Liquefaction.—Under a pressure of 36 atmospheres at 32°, carbonic acid is a limpid, colourless liquid, which is insoluble in water and in the fat oils, but is soluble in all proportions in alcohol, ether, oil of turpentine, and carburet of sulphur. Its refractive power is much less than that of water. Its expansibility by heat is greater than that of gases; for when heated from 32° to 86° F., its bulk increases from 20 to 29 volumes, while the pressure of its vapour augments from 36 to 73 atmospheres[w].

Solidification.—By an intense degree of cold, liquid carbonic acid may be solidified. Thus, when the pressure is removed from this liquid by opening a stopcock in the condensing vessel, the cold produced by the expansion is so great, that a quantity of solid carbonic acid is formed. In this state it is so intensely cold, that mercury, liquid chlorine, liquid cyanogen, &c. may be readily frozen by it. Being a very bad conductor of heat, it may be handled with impunity.

Characteristics.—Carbonic acid gas is recognised by its feebly reddening litmus, by being incombustible and a non-supporter of combustion (except in the case above mentioned), and by its forming, with a solution of lime or of baryta, a white precipitate, soluble in acetic acid.

The *carbonates* effervesce on the addition of hydrochloric acid. The evolved gas is known to be carbonic acid by the characters before stated. The soluble mono-carbonates form white precipitates in solutions of lime or baryta, soluble in excess of carbonic acid.

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[w] At the Ecole de Pharmacie, in Paris, the apparatus employed in the condensation of the gas burst, and destroyed the *préparateur* (see *Journal de Pharmacie* t. xxvii; and *London Medical Gazette*, April 16, 1841).

Before Combustion.		*After.*
2 eq. Oxygen. = 16	and 1 eq. Carbon. = 6	1 eq. Carb. Acid gas. = 22

Composition. — By burning charcoal in one volume or 16 parts, by weight, of oxygen gas, we procure one volume or 22 parts, by weight, of carbonic acid gas.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Saussure.*		*Vol.*	*Sp.gr.*		*Vol.*	*Sp.gr.*
Carbon	1	6	27·27	27·04 to 27·38	Carb. vapour	0·5 or 1	0·4166̇	Carb. Oxide gas	1	0·9722̇
Oxygen	2	16	72·73	72·96 to 72·62	Oxygen gas	1	1·1111̇	Oxygen gas	0·5	0·5555̇
Carbonic Acid	1	22	100·00	100·00 . 100·00	Carb. Acid gas	1	1·5277̇	Carb. Acid gas	1	1·5277̇

Physiological Effects. *α. On Vegetables.*—Carbonic acid gas is injurious to seeds, and diminishes or stops their germination. An aqueous solution of carbonic acid applied to the roots of plants promotes vegetation. An atmosphere containing not more than 1-8th of its volume of carbonic acid promotes the vegetation of plants exposed to the solar rays, but is injurious to those which grow in the shade[x]. The carbon of plants is derived from carbonic acid, which they take in from the atmosphere, decompose, retain the carbon, and evolve (partially or wholly, according to circumstances) the oxygen. Humus nourishes plants by presenting a slow and lasting source of carbonic acid which is absorbed by the roots[y].

β. On Animals.—The *respiration* of carbonic acid is deleterious and fatal to all classes of animals. It operates as a narcotic or stupefacient poison. That it is a positive poison, and does not act merely by excluding oxygen, as some have supposed, seems to be proved by three facts : — firstly, an atmosphere composed of 79 parts of carbonic acid and 21 of oxygen acts as a poison, although there is as much oxygen present as there is in atmospheric air ; secondly, one bronchial tube of the land-tortoise may be tied, without any serious injury to the animal ; but if, instead of tying it, the animal be made to inhale carbonic acid gas by it, death takes place in a few hours[z] ; and, thirdly, " the cases of insidious poisoning by small doses of carbonic acid scarcely admit of explanation, save on the grounds of the essentially and specifically poisonous action of carbonic acid gas, when sufficiently diluted to become respirable[a]." The impression produced on the pulmonary extremities of the par vagum, by the carbonic acid in the lungs, is supposed by some physiologists to be the ordinary stimulus to inspiration[b]. According to the experiments of Nysten[c], this gas may be *injected into the venous system* in large quantity, without stopping the circulation, and without acting primitively on thebrain; but when more is injected than the blood can dissolve, it produces death by distending the heart, as when air is injected into the veins (see p. 23). *Applied to the skin of animals*, free access of common air to the lungs being preserved, it produces, if the experiment be continued long enough, death.

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[x] Saussure, *Recherches*, p. 25, et seq. Paris, 1804.

[y] Liebig's *Organic Chemistry, in its Application to Agriculture and Physiology*, edited by L. Playfair, Ph. D. Lond. 1840.

[z] Christison, *Treatise on Poisons*, p. 745, 3d edit.

[a] Dr. Golding Bird's experiments, in the *Guy's Hospital Reports*, vol. iv. p. 75; also *London Medical Gazette*, N. S. vols. i. and ii. for 1838-9.

[b] Dr. M. Hall *on the Diseases and Derangements of the Nervous System*, p. 66. Lond. 1841.

[c] *Recherches*, p. 88.

γ. *On Man.*—If an attempt be made to *inhale* pure carbonic acid gas, the glottis spasmodically closes, so as to prevent the smallest portions from entering the lungs[d]. When mixed with more than twice its volume of air, this gas ceases to provoke spasm of the glottis, and may be taken into the lungs. It then acts as a narcotic poison. Its specific influence is exercised on the central organs of the cerebro-spinal system, which it probably gains access to, through the medium of the blood. Its action on the nervous system does not depend on its impeding the arterialization of the blood; because death may occur from the respiration of an atmosphere containing sufficient oxygen to support life *per se*, but with which is mixed carbonic acid gas. It is impossible to state the maximum quantity of this gas which may be present in the air without exciting its effects: it probably varies for different individuals, some persons being much more susceptible of its action than others. If the proportion of carbonic acid be large, the effects are almost immediately developed; whereas, if the proportion be small, they are very slowly manifested. Dr. G. Bird has shewn that an atmosphere, containing five per cent. of carbonic acid, proved fatal to a bird in thirty minutes; and it is probable that the continued respiration of an atmosphere containing a very considerably smaller proportion of carbonic acid, would be attended with dangerous and even fatal consequences.

The earliest symptom usually experienced by persons exposed to an atmosphere containing carbonic acid gas is throbbing headache, with a feeling of fulness and of tightness across the temples, and in the occipital region. Giddiness, loss of muscular power, a sensation of tightness at the chest, augmented action of the heart, and often palpitation, succeed. The ideas become confused, and the memory partially fails. A buzzing noise in the ears is next experienced; vision is impaired; and a strong tendency to sleep succeeds, or actual syncope ensues. The pulse falls below its natural standard, the respiration becomes slow and laborious, the surface cold and often livid, but the eyes retain their lustre. Convulsions, sometimes accompanied with delirium, foaming at the mouth, and vomiting, come on, and are terminated by death. On post-mortem examination, engorgement of the cerebral vessels, and sometimes serous or even sanguineous effusion, are the usual appearances[e].

Applied to the skin (care being taken that it be not inhaled) it produces a sensation of warmth and prickling or tingling, sometimes accompanied by pain, increased frequency of the pulse, sweating, and excitement of the nervous system. M. Collard de Martigny (quoted by Dr. Christison) experienced weight in the head, obscurity of sight, pain in the temples, ringing in the ears, giddiness, and an undefinable feeling of terror. *Taken into the stomach*, dissolved in water, or in the form of effervescing draughts, it allays thirst, and diminishes preternatural heat, thus acting like the other dilute acids. If it be evolved in the stomach, it distends this viscus, excites eructations, and checks both nausea and vomiting. It appears to promote the secretions of the alimentary tube, to assist the digestive process, to allay irritation, and to act as a refreshing and exhilarating substance. It is said to be diuretic and diaphoretic. Wöhler and Stehberger expressly state, that the use of carbonic acid did not increase the quantity of this substance in the urine[f]. When drunk too quickly, and in large quantity, water impregnated with this gas has been known to excite giddiness and intoxication[g]; and it is probable that champagne is indebted to this substance for part of its intoxicating powers. *Applied to ulcers and suppurating surfaces*, carbonic acid gas acts as a stimulant, improves the quality of the discharge in ill-conditioned and indolent ulcers, retards the putrefaction of the secreted matters, diminishes the unpleasant odour of foul and gangrenous sores, and promotes the separation of the dead and mortified parts.

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[d] Davy, *Researches*, p. 472.

[e] or further details, I must refer the reader to Dr. Bird's paper before cited.

USES. *a. When inhaled.*—In some diseases of the lungs, particularly phthisis, it has been proposed to mix carbonic acid gas with the atmospheric air breathed by the patient, with the view of lessening the stimulant influence of the oxygen, to diminish the quantity and improve the quality of the matter expectorated, and at the same time to relieve the hectic symptoms. But the practice is dangerous. Part of the benefit said to have been derived by consumptive patients from a residence in cow-houses, has been ascribed to the inhalation of carbonic acid gas (see p. 18).

β. Taken into the stomach, carbonic acid is a most valuable remedy for checking vomiting, and diminishing irritable conditions of this viscus. The best mode of exhibiting it is, I believe, in the form of an effervescing draught, composed of citric acid and bicarbonate of potash. In fever, it is an excellent refrigerant; especially serviceable in those cases which are accompanied with gastric irritation. In that form of lithiasis attended with a white or phosphatic deposit in the urine, carbonic acid water may be taken with advantage; but in this case the common effervescing draught (made of a vegetable acid and a carbonated alkali) must not be substituted for it, on account of the alkaline property communicated by the latter to the urine. From its antiseptic qualities, carbonic acid has been administered internally, in those diseases which are supposed to be connected with a putrescent tendency, as typhoid fevers, &c.[h]

γ. Clysters of carbonic acid gas have been employed in certain affections of the rectum and colon,—for example, ulceration of the rectum, especially when of the kind commonly denominated cancerous. Mr. Parkin[hh] has recommended them in dysentery. The gas may be introduced into the rectum from a bladder, or solutions of tartaric acid and bicarbonate of soda may be injected in the usual way.

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[f] Duncan, *Supplement to the Edinb. Disp.* p. 223.

[g] Fodéré, *Méd Légale.*

[h] See Dobson's *Medical Commentary on Fixed Air,* 2nd ed. Lond. 1785.

δ. *A stream of carbonic acid gas* has been applied to the *uterus* with great benefit, in a painful condition of this viscus, as I have already mentioned (see p. 155).

ε. *Applied to the skin*, care being taken that the gas be not inhaled, it is employed either in its gaseous form, or dissolved in water. It is, of course, adapted to those cases where it is desirable to excite the vascular system, especially of the skin, and to cause perspiration; while, on the other hand, it is objectionable in inflammatory cases. In chlorosis, amenorrhœa, dyspepsia, hysteria, scrofula, &c., it has also been found useful.

ζ. It has been *applied to cancerous and other ulcers*, to allay pain, to improve the quality of the secretions, and to check sloughing. It is readily administered by means of a tube connected with a bottle generating the gas. In this case it should be procured by the action of dilute sulphuric acid on marble; for, if hydrochloric acid be employed, the gas requires washing, to remove any of this acid which may pass over with it. Or it may be used in the form of solution, in which case carbonic acid water is employed. Or, lastly, we may apply the *yeast poultice* (see *Cataplasma Fermenti*).

η. *In ophthalmia*, of a chronic kind, a stream of carbonic acid gas, directed on the inflamed part, has appeared to be serviceable. I have seen it used in a case of scrofulous ophthalmia: the patient recovered under its use, after the ordinary plans of treatment had been unsuccessfully tried.

Administration.—Internally, carbonic acid may be administered under the form of *carbonic acid water* or *effervescing draught*. The latter, however, cannot always be employed as a substitute for the former. Where no objection exists to the use of the vegetable salts of potash, the ordinary *effervescing draught* may be administered. In febrile disorders, when the stomach is in a very irritable condition, I prefer a draught made with citric acid and the bicarbonate of potash to other modes of employing carbonic acid.

Another mode of administering carbonic acid is under the form of the *acidulous* or *carbonated mineral waters* (see p. 268).

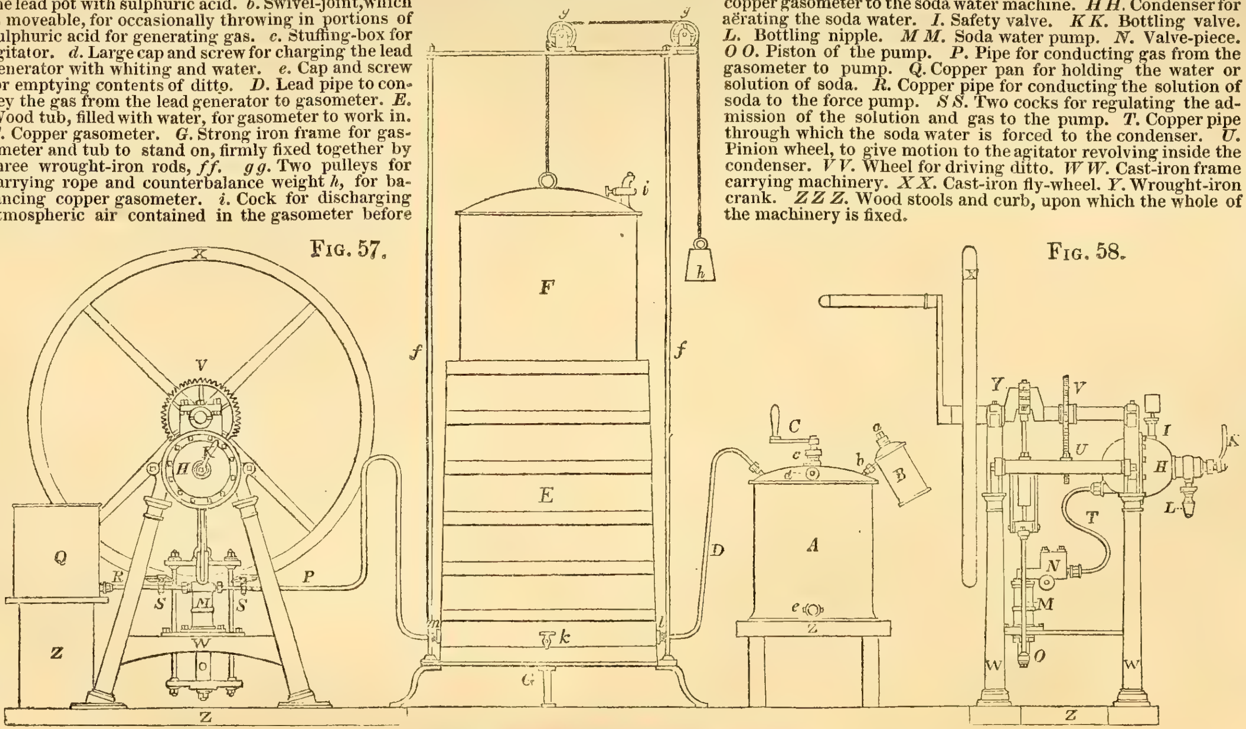
Antidotes.—In accidents arising from the inhalation of carbonic acid gas proceed as follows:—remove the patient immediately into the open air, and place him on his back, with his head somewhat elevated. Produce artificial respiration by pressing down the ribs, forcing up the diaphragm, and then suddenly removing the pressure. Dash cold water over the body, and abstract a small quantity of blood either by venesection or cupping. Apply bottles of hot water to the feet. Stimulants of various kinds may be employed, either internally by the stomach, or in the form of frictions, or inhalations of ammonia, or air impregnated with chlorine gas.

[hh] *On the Efficacy of Carbonic Acid Gas in the Diseases of Tropical Climates; with Directions for the Treatment of Acute and Chronic Stages of Dysentery.* Reviewed in the *London Medical Gazette*, vol. xviii. p. 777. 1836.

AQUA ACIDI CARBONICI; *Carbonic Acid Water; Bottle Soda Water; Soda Water from the Fountain; Artificial Seltzer Water.*—This is prepared by condensing carbonic acid gas (generated by the action of sulphuric acid on whiting) in water. The operation is effected by means of *Tyler's Improved Soda-Water Apparatus* (figs. 57 & 58)[1].

A. Lead generator for making the gas. *B*. Lead pot for holding sulphuric acid. *C*. Handle for moving the agitator of the receiver, which stirs up the ingredients in the lead generator. *a*. Cap and screw for charging the lead pot with sulphuric acid. *b*. Swivel-joint, which is moveable, for occasionally throwing in portions of sulphuric acid for generating gas. *c*. Stuffing-box for agitator. *d*. Large cap and screw for charging the lead generator with whiting and water. *e*. Cap and screw for emptying contents of ditto. *D*. Lead pipe to convey the gas from the lead generator to gasometer. *E*. Wood tub, filled with water, for gasometer to work in. *F*. Copper gasometer. *G*. Strong iron frame for gasometer and tub to stand on, firmly fixed together by three wrought-iron rods, *ff*. *gg*. Two pulleys for carrying rope and counterbalance weight *h*, for balancing copper gasometer. *i*. Cock for discharging atmospheric air contained in the gasometer before making the gas. *k*. Cock for occasionally emptying the water out of the tub. *l*. Union joint, to which is fixed a copper pipe, passing through the water in the tub, to deliver the gas as generated into the copper gasometer. *m*. Another union joint, with a similar copper pipe passing through the water in the tub, and projecting two or three inches above the surface of the water, to convey the gas from the copper gasometer to the soda water machine. *H H*. Condenser for aërating the soda water. *I*. Safety valve. *K K*. Bottling valve. *L*. Bottling nipple. *M M*. Soda water pump. *N*. Valve-piece. *O O*. Piston of the pump. *P*. Pipe for conducting gas from the gasometer to pump. *Q*. Copper pan for holding the water or solution of soda. *R*. Copper pipe for conducting the solution of soda to the force pump. *S S*. Two cocks for regulating the admission of the solution and gas to the pump. *T*. Copper pipe through which the soda water is forced to the condenser. *U*. Pinion wheel, to give motion to the agitator revolving inside the condenser. *V V*. Wheel for driving ditto. *W W*. Cast-iron frame carrying machinery. *X X*. Cast-iron fly-wheel. *Y*. Wrought-iron crank. *Z Z Z*. Wood stools and curb, upon which the whole of the machinery is fixed.

FIG. 57. FIG. 58.



Tyler's Improved Soda-Water Apparatus.

Fig. 57. Front view of the Machine.

Fig. 58. End view of the same.

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[1] These figures are taken from Ure's *Dict. of Arts and Manufactures*, p. 1156. London, 1839.

At the ordinary temperature and pressure of the atmosphere, one volume of water absorbs one volume of carbonic acid gas, and acquires a sp. gr. of 1·0018. By doubling the pressure, the quantity of gas absorbed by the water is doubled, and so on for other degrees of pressure; for Dr. Henry has shown, that the quantity of gas forced into the water is directly as the pressure. In the United States' Pharmacopœia five volumes of gas are directed to be condensed in one volume of water.

The Bottle Soda Water of the shops is, in general, carbonic acid water only. Some few manufacturers introduce a small portion of soda (see *Aqua Sodæ Supercarbonatis*).

Carbonic acid water is a brisk, sparkling liquid. It has a pungent, acidulous taste; reddens litmus; and causes, with lime water, a white precipitate (*carbonate of lime*), which is re-dissolved by an excess of carbonic acid water.

Carbonic acid water is a refreshing, refrigerant beverage, operating as an anti-emetic, diaphoretic, and diuretic. In febrile disorders it is used to allay thirst, check nausea, and promote secretion. In lithiasis it is employed to check the formation of the phosphates in the urine. It is a convenient vehicle for the exhibition of many medicines, the nauseating qualities of which it diminishes. By the aid of it, extemporaneous imitations of carbonated magnesian and carbonated chalybeate waters may be readily made (see *Aqua Magnesiæ Supercarbonatis* and *Aqua Ferri Supercarbonatis*).

2. AC'IDUM OXAL'ICUM[j].—OXALIC ACID.

HISTORY.—This acid was discovered by Scheele, though the credit of its discovery was for a long time given to Bergmann[k].

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. *In the Inorganised Kingdom.*—Oxalic acid, in combination with the protoxide of iron, constitutes the mineral denominated by Rivero, *Humboldtine*; by Necker and Beudant, *Humboldtite.*

β. *In the Organised Kingdom.*—Oxalic acid is found in both plants and animals, but principally in the former.

Oxalic acid, in combination with either lime or potash, is a constituent of a considerable number of plants, especially those belonging to the orders *Polygonaceæ* and *Lichenaceæ*. Oxalate of lime is found in Rhubarb, Bistort, many Lichens, &c. Some Lichens contain nearly half their weight of oxalate of lime. In *Variolaria faginea* [V. communis], Braconnot found 47·4 per cent. of this salt. Combined with potash, oxalic acid is found in *Oxalis Acetosella*, *Rumex Acetosa*, Rhubarb, &c. Oxalate of soda is found in *Salsola*. A solution of free oxalic acid is said to exude from the hairs of *Cicer Arietinum*, but the accuracy of the statement is doubtful.

Oxalate of lime constitutes the Mulberry Calculus, and is found in the Liquor Allantoidis of the cow.

PREPARATION.—Oxalic acid is obtained by the action of nitric acid on sugar or potato starch. Treacle is usually employed in this country as a substitute for solid sugar. The process is generally conducted in open earthenware jars, heated by a warm water bath. The nitrous vapours evolved are usually allowed to escape into the air. In France, attempts have been made to economise them by their employment in the manufacture of sulphuric acid (see *Sulphuric Acid*). To prevent their noxious influence on the workmen and the surrounding neighbourhood, as well as to economise them, a patent has been taken out to conduct the process in closed vessels connected with receivers and condensers, by which the vapours are condensed and collected again to be used[l].

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[j] This acid has been omitted, inadvertently I presume, in the Edinburgh Pharmacopœia, though it is directed to be employed in the preparation of oxalate of ammonia.

[k] See Thomson's *System of Chemistry*, vol. ii. p. 15, 7th ed. Lond. 1831.

Oxalic acid is obtained by digesting, by aid of a gentle heat, one part of sugar, or, better still, of potato starch, in 5 parts of nitric acid of sp. gr. 1·42, diluted with 10 parts of water, as long as gaseous products are evolved; by evaporation the acid is obtained in crystals, which may be purified by a second crystallization, after being well dried on paper or porous earthenware. From 12 parts of potato starch, 5 of the acid are obtained. The mother liquor should be treated with an additional quantity of acid, and again warmed, when a second crop of crystals will be obtained: this is repeated until the solution is quite exhausted[m].

The formation of oxalic acid depends on the oxidation of organic matter, at the expense of part of the oxygen of the nitric acid, while nitrous vapours are given out. Those organic matters, as sugar and starch, which contain oxygen and hydrogen in the same proportion as water, yield it in the greatest quantity. One equivalent of anhydrous sugar ($C^{12} H^9 O^9$), and eighteen equivalents of oxygen (O^{18}), contain the elements of six equivalents of anhydrous oxalic acid ($6 C^2 O^3$), and nine equivalents of water ($9 HO$). But the process is not so simple as this calculation would lead us to suppose. Part of the carbon of the sugar escapes in the form of carbonic acid gas. The mother liquor contains, besides some acetic acid, saccharic acid ($C^{12} H^5 O^{11}$); which, when acted on by a further portion of nitric, is converted into oxalic and carbonic acids. If the nitrous vapours be conveyed into a condenser, nitric and nitrous acids are deposited.

PROPERTIES.—The crystals of oxalic acid are colourless, transparent prisms, which belong to the oblique prismatic system. They are usually flattened, six-sided (by the truncation of one pair of the lateral edges), and have two or four terminal planes.

Crystallized oxalic acid has often been mistaken for Sulphate of Magnesia, and the consequence has been fatal in many instances. Sulphate of Zinc and Bicyanide of Mercury are likewise apt to be confounded with this acid.

The crystals of oxalic acid taste and react on vegetable colours powerfully acid. When pure they have no odour. Exposed to a warm air they effloresce, evolve 28 per cent. (equal to two equivalents) of water, and become a pulverulent residue (*hydrate of oxalic acid*). When heated rapidly to 350° F. they fuse, evolve water, and the hydrate of the acid sublimes, a portion of it at the same time undergoing decomposition, but no residue being left. They dissolve in 8 parts of water at 60° F., in their own weight of boiling water, and in 4 parts of alcohol at 60° F. By the action of oil of vitriol, aided by heat, they are resolved into water, which remains with the sulphuric acid, and equal volumes of carbonic acid and carbonic oxide gases.

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[l] *Repertory of Patent Inventions*, N. S. vol. vii. p. 5. Lond. 1837.—A patent has been taken out for preparing this acid in leaden vessels, and for obtaining it from potatoes (*Ibid.* N. S. vol. xv. p. 363. Lond. 1841).

[m] Liebig, in Turner's *Elements of Chemistry*, p. 698, 7th ed. Lond. 1840.

Characteristics.—Oxalic acid reddens litmus, and is volatilized by heat. Nitrate of silver, added to a solution of it, yields a white precipitate (*oxalate of silver*), which is soluble in nitric acid, and when dried and heated on the point of a knife, by the flame of a candle or spirit lamp, becomes brown on the edge, very feebly detonates, and is completely dissipated, being converted into water, carbonic acid, and metallic silver. With lime water, or a solution of chloride of calcium, oxalic acid yields a white precipitate (*oxalate of lime*), insoluble, or nearly so, in excess of oxalic acid, readily soluble in nitric acid, and slightly so in hydrochloric acid. If the precipitate be collected, dried, and calcined, it yields quicklime. With sulphate of copper, oxalic acid yields a bluish white precipitate (*oxalate of copper*). It reduces the sesquichloride of gold.

To detect oxalic acid in oxalate of lime, proceed as follows:—boil the oxalate with a solution of carbonate of potash for two hours, and filter. The liquor contains oxalate and carbonate of potash. Add acetate of lead, collect the precipitate (*oxalate and carbonate of lead*), suspend it in water, through which sulphuretted hydrogen is to be passed; filter (to get rid of the dark sulphuret of lead), boil the clear liquor, which is a solution of oxalic acid, and test as above for the free acid.

If the oxalate of lime were mixed with organic matter, the filtered liquor should be feebly acidulated with nitric acid, before adding the acetate of lead. The acidulated liquor should be filtered, rendered faintly alkaline by carbonate of potash, again filtered, then mixed with acetate of lead, and the precipitate treated as above.

COMPOSITION.—Hypothetical or anhydrous oxalic acid, as it exists in dry oxalate of lead, has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Or,*	*Atoms.*	*Eq. Wt.*	*Per Cent.*
Carbon	2	12	33·$\dot{3}$	Carbonic Acid	1	22	61·1
Oxygen	3	24	66·$\dot{6}$	Carbonic Oxide	1	14	38·9
Hypothetical Oxalic Acid	1	36	100·0		1	36	100·0

Crystallized oxalic acid contains three equivalents of water, of two of which it may be deprived by heat, leaving, what has been termed, *hydrate of oxalic acid.* The composition of these two substances is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*		*Atoms.*	*Eq. Wt.*	*Per Cent.*
Anhydrous Oxalic Acid	1	36	57·14	Anhydrous Oxalic Acid	1	36	80
Water	3	27	42·86	Water	1	9	20
Crystallized Oxalic Acid	1	63	100·00	Hydrate of Oxalic Acid	1	45	100

Some chemists regard the hydrate of oxalic acid as a real hydracid, composed of $C^2\,O^4 + H$.

IMPURITY.—The crystals of oxalic acid of commerce are sometimes contaminated with nitric acid. In this state they have usually a faint odour, and stain the cork of the bottle, in which they are kept, yellow. If they be exposed to a warm atmosphere, the nitric acid escapes along with the water of crystallization.

Physiological Effects. α. *On Vegetables.*—A solution of oxalic acid acts as a poison to plants[n]. The acid (solid ?) has been said to promote the germination of old seeds[o]; but I suspect the statement to be inaccurate.

β. *On Animals.*—The best series of experiments on the effects of this acid on animals are those of Christison and Coindet[p]. They found that concentrated solutions of half-ounce doses of this acid introduced into the stomachs of cats and dogs caused exquisite pain, violent attempts to vomit, dulness, languor, great debility, and death in from two to twenty minutes. Post-mortem examination showed corrosion of the inner coat of the stomach. Large doses of a dilute solution caused great depression of the heart's action; and small doses gave rise to tetanus or narcotism. Furthermore, the acid acts with great violence, and produces nearly the same effects, to whatever part of the body it is applied. From these results it has been inferred that the concentrated acid is a corrosive poison,—while the dilute acid ceases to be corrosive, but, becoming absorbed, acts on the brain, spinal cord, and heart.

It appears to me absurd to suppose, as is usually done, that a dilute solution ceases to act chemically. It does not indeed destroy the gastric membrane as a concentrated solution does, but doubtless it must effect some chemical change on the blood when it gains access to it: though the precise alteration may hitherto have evaded notice. We know that a twentieth part of oxalic acid, added to boiling syrup, renders it thin, and incapable of crystallizing; and we may, therefore, imagine that its action on other organic substances may be equally energetic; and thus alterations may be effected in the condition of the blood, which, though not very marked, may nevertheless be sufficient to render this fluid incapable of supporting life[q].

γ. *On Man.*—The effects of oxalic acid on the human subject vary somewhat with the dose. When this is large, and the solution concentrated, acute pain is experienced; but, after small doses and dilute solutions, this symptom is not well marked. Vomiting is usually present. The circulation is always depressed; the pulse being feeble or failing, and the surface cold and clammy. Nervous symptoms (such as lassitude, weakness of the limbs, numbness, pain in the back extending down the thighs, and, towards the end, convulsions) have sometimes, but by no means invariably, made their appearance. But death follows so speedily after the injection of large doses ("few of those, who have died, survived above an hour," *Christison*), that the symptoms have not been fully made out. If life be prolonged for a few hours, symptoms of gastro-enteritis are observed. Post-mortem examination discovers irritation and often corrosion of the stomach.

Some years since I opened the body of a man, who died in twenty minutes after swallowing oxalic acid by mistake for Epsom salts. The post-mortem examination was made a few hours after death, and while the body was quite warm. The stomach presented a diffused redness, like that of a part affected with erysipelas. The epithelium was destroyed; and presented, in patches, the appearance of the scalded cuticle, or of the pellicle which forms on the surface of boiling saline solutions. I have a wax model of the stomach, executed by the late Mr. Miller.

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[n] Marcet, quoted by De Candolle, in his *Physiologie Végétale*, t. iii. p. 1355. Paris, 1832.

[o] *Repertory of Patent Inventions*, vol. xiii. p. 408. 1832.

[p] *Edinburgh Medical and Surgical Journal*, vol. xix.—In Wibmer's work (*Die Wirkung*, &c. Bd. iv. S. 35) will be found a notice of the experiments of Rave and Klostermann.

[q] I have before noticed some of Drs. Christison and Coindet's experiments with this acid: see pp. 107, and 119.

USES.—Oxalic acid is not at the present time used in medicine. In France, *Tablettes d'Acide Oxalique* are prepared. Either free or combined with ammonia, it is a valuable test for lime. It is employed for removing ink stains and iron moulds from linen; for cleaning the leather of boot-tops; and for certain styles of discharge in calico-printing.

ANTIDOTES.—Administer as speedily as possible large quantities of chalk, whiting, or magnesia, suspended in water; by which inert earthy oxalates are formed in the stomach. In the absence of these antidotes, large quantities of warm water may be administered, and at the same time vomiting is to be promoted by tickling the throat. Small quantities of water may prove injurious by favouring absorption. Alkalis do not deprive the acid of its poisonous operation. The stomach-pump and emetics may be used; but on account of the rapidity with which this acid acts, it is not advisable to lose time by their application, until after the antidote has been administered. The same treatment is to be adopted in poisoning by the following salts:—

1. AMMONIÆ OXALAS, E. *Oxalate of Ammonia.*—(Oxalic Acid, ℥iv.; Carbonate [Sesquicarbonate] of Ammonia, ℥viij.; Distilled Water, Oiv. Dissolve the carbonate in the water, add gradually the acid, boil, and concentrate sufficiently for crystals to form on cooling.) This salt consists of 1 eq. Oxalic Acid 36, 1 eq. Ammonia 17, and 2 eq. Water 18 = 71. By heat it suffers decomposition, and yields *oxamide* (*oxalamide*), composed of HN^2, $C_2 O_2$. Oxalate of ammonia was introduced into the Edinburgh Pharmacopœia as a test for calcareous solutions, with which it produces a white precipitate (*oxalate of lime*), which is readily soluble in nitric acid, but is only moderately soluble in hydrochloric acid. It does not occasion any precipitate in solutions of the magnesian salts; hence it is a valuable agent for separating lime from magnesia. According to the experiments of Drs. Christison and Coindet[qq], it is but little inferior in the energy of its operation on the body to oxalic acid. Ninety grains, which contain thirty-six grains of oxalic acid, killed a strong cat in nine minutes. The symptoms were tetanus and coma.

2. POTASSÆ QUADROXALAS; *Quadroxalate of Potash.*—This salt is sold in commerce as *Binoxalate of Potash, Sal Acetosellæ, Salt of Woodsorrel*, or *Essential Salt of Lemons.* It is made by neutralizing one part of oxalic acid with carbonate of potash, and adding to the solution three parts more of acid. It crystallizes in colourless transparent prisms of the doubly oblique prismatic system; and which consist of 4 eq. Oxalic Acid 144, 1 eq. Potash 48, and 7 eq. Water 63 = 255. If three parts of the salt be converted into carbonate by heat, and added to a solution of one part, the neutral oxalate of potash is formed (Liebig). The commerical quadroxalate is not pure; for I find that it yields, by ignition in a covered crucible, carbonate of potash, contaminated with carbonaceous matter; whereas the pure quadroxalate yields the carbonate only. It is employed for removing ink stains and iron moulds from linen, and for decolorizing straw used for bonnet-making. This salt was formerly used in medicine as a refrigerant. In France, *Tablettes ou Pastilles la Soif* are prepared with it. It possesses poisonous properties similar to, but less energetic than, oxalic acid. A case of poisoning by about an ounce of this salt has been published by my friend and former pupil, Mr. John Jackson[r]. The accident was not known for an hour and a half after it occurred. The symptoms were those of great depression of the heart's action, but without either tetanus or coma. The eyes were sore, the vision dim, the conjunctiva a good deal injured, and the pupils dilated. The patient ultimately recovered.

[qq] *Edinburgh Medical and Surgical Journal*, vol. xix. p. 190.

III.—OXYHYDROCARBONS.

1. AL'COHOL, *L. E. D.*—ALCOHOL.

History.—Fermented liquors were known in the most remote ages of antiquity. The Sacred Historian tells us[s], that, after the flood (which is supposed to have occurred 2,348 years before Christ), "Noah planted a vineyard: and he drank of the wine, and was drunken." Homer[t], the most ancient of all the profane writers whose works have reached us, and who lived more than 900 years before the Christian era, also frequently mentions wine, and notices its effects on the body, mind, &c. Herodotus[u], who wrote 445 years before Christ, tells us, that the Egyptians drank a liquor fermented from barley.

It is uncertain at what period vinous liquors were first submitted to distillation. Morewood[w] considers the Chinese to have been acquainted with this process long before the rest of Asia, Africa, and Europe. It is usually stated, that Albucasis, who is supposed to have lived in the 12th century, taught the mode of procuring spirit from wine[x]. But as the process of distillation was certainly known long before his time[y], it is highly probable that his predecessors had submitted fermented liquors to this operation. Raymond Lully[z], in the 13th century, was acquainted with spirit of wine (which he called *aqua ardens*), as well as of the mode of depriving it of water by means of carbonate of potash.

Preparation.—The preparation of alcohol may be divided into three stages: the production of a fermented vinous liquor; the preparation from this of an ardent spirit by distillation; and, lastly, rectification or purification.

Stage 1. *Production of a Vinous Liquor.*—When vegetable substances are placed in contact with air and moisture, they undergo that kind of decomposition which is denominated *fermentation*. The products of this process vary at different periods or stages; and on this depends the distinction into kinds or varieties of fermentation. Thus starchy liquids, under some circumstances, become saccharine; the process being termed the *saccharine* fermentation. Sugar dissolved in water, and mixed with nitrogenous matter *(ferment)*, is converted into carbonic acid and alcohol; and to this process the name of *vinous* fermentation is applied. Under some circumstances, mannite, lactic acid, and a syrupy mucilage, are formed by the action of the nitrogenous or albuminous principles of vegetable juices on the sugar: this change has been denominated the *viscous* or *mucilaginous* fermentation[a]. Vinous liquids are capable of generating acetic acid, and the process is denominated *acetous* fermentation. Lastly, most vegetable substances are slowly converted into gases, and a substance called vegetable mould (*humus*), constituting the process termed the *putrefactive* fermentation.

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[r] *London Medical Gazette*, Dec. 18, 1840. In the same journal for March 5th, 1841, is a case of poisoning by about two scruples of oxalic acid swallowed in combination with carbonate of soda *(superoxalate of soda?)*.

[s] *Genesis*, ch. ix.

[t] *Odyssey*, ix. and xxi.

[u] *Euterpe*, lxxvii.

[w] *Essay on Inebriating Liquors*, p. 107. Lond. 1824.

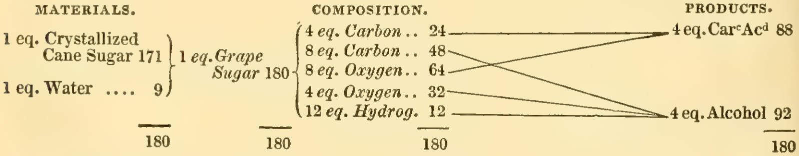
[x] Gmelin, *Handbuch d. Chemie*, Bd. ii. p. 274.

[y] Dr. Royle's *Essay on the Antiquity of Hindoo Medicine*, p. 46. London, 1837.

[z] Thomson's *History of Chemistry*, vol. i. p. 41, Lond. 1830; *Testamentum Novissimum*, p. 2. Edit. Basil, p. 2. 1600.

To produce a vinous liquid, it is necessary that there be present sugar (or some substance capable of forming sugar, as starch), a certain quantity of water, and a ferment (usually yeast). Moreover, a certain temperature (the best is between 70° & 80° F.) is requisite.

Both grape and cane sugar yield alcohol by fermentation. It is highly probable, however, "that cane sugar, before it undergoes vinous fermentation, is converted into grape sugar by contact with the ferment; and that, consequently it is grape sugar alone which yields alcohol and carbonic acid[b]." On this view, the one equivalent or 171 parts of crystallized cane sugar unite with one equivalent or 9 parts of water, to form one equivalent or 180 parts of grape sugar, which, in the process of fermentation, are converted into four equivalents or 88p arts of carbonic acid, and four equivalents or 92 parts of alcohol.



Vinous fermentation, then, is the metamorphosis of sugar into alcohol and carbonic acid. But as the elements of the yeast or other ferment take no part in the transformation, (that is, do not enter into combination with the elements of the sugar) some difficulty has been experienced in accounting for its agency in exciting fermentation. Two opinions are entertained respecting it: by some it is regarded as a putrefying substance, whose atoms are in continual motion, which they communicate to the constituents of the sugar, and thereby destroy its equilibrium[c]; by others, yeast[d] is considered to consist essentially of seeds or sporules, whose vegetation is the immediate cause of the metamorphosis of the sugar.

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[a] Liebig, in Turner's *Elements of Chemistry*, 7th ed. p. 947. Lond. 1840.

[b] *Ibid.* p. 946.

[c] The view above referred to is that entertained by Liebig; for full details of it I must refer to his work, entitled *Organic Chemistry, in its Application to Agriculture and Physiology*, edited by L. Playfair, Ph. D., Lond. 1840; and Turner's *Elements of Chemistry*, 7th ed. p. 944, 1840. Berzelius (*Journ. de Chimie Médicale*, t. iii. p. 425, 2^nde Série, 1837) ascribes decompositions of this kind, which are effected by the mere contact of one body with another, to a new force which he supposes to be called into action, and which he denominates *catalytic force* (from καταλύω, I loosen or dissolve).

[d] The Yeast Plant will be described and figured in a subsequent part of this work, to which the reader is referred. For further details, consult the Memoirs of Schwann (Poggendorf's *Annalen der Physik.* Bd. XLI. p. 184; *Pharmaceutisches Central-Blätt* für 1837, S. 547; and Meyen's *Report on*

The liquid obtained by the vinous fermentation has received different names, according to the substance from which it is obtained. When procured from the expressed juices of fruits, as grapes, currants, gooseberries, &c. it is denominated *Wine* (*Vinum*); from a decoction of malt and hops, *Ale* or *Beer* (*Cerevisia*); and from a mixture of honey and water, *Mead* (*Hydromeli*). Fermented infusions of barley (raw grain and malt), prepared by the distillers of this country for the production of ardent spirit, are technically denominated *Washes.*

The liquid obtained by vinous fermentation consists of *water, alcohol, colouring* and *extractive matters, œnanthic ether, volatile oil* (*e. g.* oil of potatoes, oil of grain, &c.), *various acids* and *salts.*

Stage 2. *Production of Ardent Spirits.*—By the distillation of a vinous liquid we obtain *Ardent Spirit* (*Spiritus Ardens*). When grape wine is employed, the spirit is called *Brandy* (*Spiritus Vini Gallici,* Ph. Lond.); when the vinous liquid is obtained by the fermentation of molasses or treacle, the spirit is termed *Rum* (*Spiritus Sacchari*); when the liquid is a fermented infusion of grain (*Wash*), the spirit is denominated *Corn Spirit* (*Spiritus Frumenti*); and when the vinous liquid is either a fermented infusion of rice or toddy (*Palm Wine*), the spirit is named *Arrack* (if from the former, it is termed *Spiritus Oryzæ*). The well-known liquors called *Gin, Hollands* or *Geneva,* and *Whiskey,* are corn spirits flavoured.

Ardent spirit, from whatever source obtained, consists of *water, alcohol, volatile oil,* and, frequently, *colouring matter.* The following are, according to Mr. Brande[e], the average quantities of alcohol (sp. gr. 0·825 at 60° F.) in some kinds of ardent spirit:—

100 *parts* (*by measure*) *of*	*Alcohol* (*by measure*).	100 *parts* (*by measure*) *of*	*Alcohol* (*by measure*).
Brandy contain	55·39	Whiskey (Scotch) contain	54·32
Rum	53·68	Whiskey (Irish)	53·90
Gin	51·60		

Each variety of ardent spirit has an aroma peculiar to itself, and which is characteristic of the substance from which it is produced. This depends on volatile oil.

When wash is distilled, the fluid that comes over is called *Singlings,* or *Low Wines.* It is concentrated or *doubled* by a second distillation, by which *Raw Corn Spirit* is obtained. Towards the end of the distillation the distilled product acquires an unpleasant odour and taste from the presence of volatile oil, and is called *Faints.* Raw corn spirit is sold by the distiller to the rectifier at 11 or 25 per cent. *over proof,* in the language of Sikes's hydrometer.

Stage 3. *Rectification.*—The object of the rectifier is to deprive ardent spirit of its volatile oil and water. This is effected by re-

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the Progress of Vegetable Physiology during the year 1837, Lond. 1839), Cagniard-Latour and Turpin (*Biblioth. Univ. de Genève,* Nov. 1838; and Jameson's *Edinb. New Phil. Journ.* vol. xxv.), Keitzing (*Répertoire de Chimie,* t. iii., Paris, 1838), Quevenne (*Journ. de Pharm.* t. xxiv.); and Turpin, (*Mémoires de l'Académie Royale des Sciences de l'Institut,* t. xvii., Paris, 1840).

[e] *Phil. Trans.* for 1811 and 1813.

peated distillations, and by the use of pearlash (carbonate of potash), which, by its powerful affinity for water, checks the rise of this fluid in distillation. In this way is procured the liquid called *Rectified Spirit* (*Spiritus rectificatus*, L. E. D.), which is sold by the rectifier to the chemist or apothecary.

1. Corn Spirit Oil; *Oil of Grain; Potato Spirit Oil; Fuselöl; Hydrate of Amule; Amilic Alcohol; Bihydrate of Amiline.*—All ardent spirits contain a volatile oil which the Germans[f] call *Fuselöl.* In 1825, Pelletan[g] described that obtained from Potato Spirit, and which has been subsequently examined, in 1834, by Dumas[h], and in 1839, by Cahours[i]. The oil from corn spirit was described several years ago by Buchner[j]. It has been long known to Messrs. Bowerbank, rectifiers, of London, who obtain it in the rectification of corn spirit. From them I procured it several years ago, under the name of *oil of grain;* and, in 1836, noticed it in my lectures[k]. In 1839, I gave a short description of its properties in the first edition of this work. It has since been more completely examined by Dr. Apjohn[l]. Under the name of *Oleum siticum,* Mulder[m] has described a peculiar oil, which he obtained from corn spirit.

Oil of grain, as I received it from Messrs. Bowerbank, is a limpid, transparent liquid, of a pale yellow colour, and having a very nauseous odour and an acid taste. The inhalation of its vapour produces an unpleasant and persistent sensation in the throat. When washed with water (to remove the alcohol), and subsequently distilled from chloride of calcium (to deprive it of water), it is quite colourless, and had, according to my experiments, a sp. gr. of 0·833 at 56° F. [0·813 at 60°, *Apjohn*]. It boils at about 268° F. Dr. Apjohn failed to congeal it at — 6° F.; but Cahours congealed the oil from potato spirit at — 4° F. It burns in the atmosphere with a flame like that of light carburetted hydrogen gas [with a bluish white flame, *Cahours*]. It dissolves iodine; and, according to Dr. Apjohn, is a good solvent for fats, resins, and camphor. It is not miscible with water, which, however, sparingly dissolves it. Neither is it miscible with liquor ammoniæ, nor with liquor potassæ. It dissolves in nitric acid, but acquires a slightly yellowish red tinge; and, when the mixture is heated, violent re-action takes place: nitrous fumes mixed with nitric ether are so rapidly evolved, that, if the experiment be performed in a tubulated retort, the stopper is sometimes driven out with considerable violence. When mixed with oil of vitriol, a violet- or blood-red-coloured thick liquid, with the evolution of a mint-like odour, is produced, and, according to Cahours, *sulphoamulic acid* (bisulphate of oxide of amule $C^{10}H^{11} + O + 2\,SO^3 + Aq.$) is formed. When distilled with dry phosphoric acid it yields, according to the same authority, a carbo-hydrogen, called *amilene* ($C^{10}H^{10}$). Potassium rapidly decomposes it with the evolution of hydrogen. If it be heated with fused potash, hydrogen is disengaged, and a compound of potash and *valerianic acid* ($C^{10}H^9O^3 + Aq.$) is formed.

This oil is composed of carbon, hydrogen, and oxygen. Cahours regards it as the hydrated oxide of a hypothetical base, called *amule* or *amyle* ($C^{10}H^{11}$), and Liebig has adopted his views.

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Apjohn.*	*Dumas.*	*Cahours.*
Carbon	10	60	68·18	68·13	68·6	68·90
Hydrogen	12	12	13·64	13·33	13·6	13·58
Oxygen	2	16	18·18	18·54	17·8	17·52
Corn Spirit Oil	1	88	100·00	100·00	100·0	100·00

Or,	*Atom.*	*Eq. Wt.*
Amule	1	71
Oxygen	1	8
Water	1	9
Hydrate of Oxide of Amule	1	88

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[f] L. Gmelin, *Handb. d. Chemie*, Bd. ii. S. 367.

[g] *Ann. de Chim. et de Physiq.* t. xxx. p. 221; and *Journ. de Chim. Méd.* t. i. p. 76.

[h] *Ann. de Chim. et de Physiq.* t. lvi. p. 314.

[i] Ibid. t. lxx. p. 81.

[j] *Repertorium*, xxiv. 270.

[k] *London Medical Gazette*, vol. xviii. p. 963.

[l] *Lond. Edin. and Dubl. Phil. Mag.* vol. xvii. p. 86. 1840.

[m] *Pharmaceutisches Central-Blätt* für 1837, S. 807.—*Siticus,* from σιτικὸς, of or pertaining to corn.

I am informed by Messrs. Bowerbank, that they obtain from 500 gallons of corn spirit about one gallon of oil, which they employ as a substitute for lamp oil.

2. Œnanthic Acid and Œnanthic Ether.—The oily liquid obtained in the distillation of wine is a mixture of Œnanthic acid and Œnanthic ether. (See *Vinum.*)

Properties of Rectified Spirit.—The liquid sold by rectifiers as rectified spirit (*Spiritus rectificatus*, L. E. D.) varies from 54 to 60, or even 64 *per cent. over proof*, in the language of Sikes's hydrometer. Hatters employ that at 54 or 56; varnish-makers that at 58 per cent. over proof. The London College fixes the sp. gr. at 0·838 at 62° F.; the Edinburgh College at 0·838, or under, at 60° F.; the Dublin College at 0·844 at 51° F., or 0·840 at 60° F.

Purity.—Rectified spirit, besides having the sp. gr. above mentioned, should be colourless, transparent, and not rendered turbid on the addition of water. "In taste and smell it resembles wine," *(Ph. L.)* Its freedom from other substances than alcohol and water is to be determined partly by the purity of its odour, by the absence of any acid or alkaline reaction, and by its easy and complete volatility. It is frequently contaminated with the *oil of corn spirit;* of the presence of which there are two tests, sulphuric acid and nitrate of silver. If colourless oil of vitriol be added to rectified spirit, it causes a red tinge (see p. 348) if the oil be present. According to Vogel, nitrate of silver is a more delicate test for the oil; if it be mixed with spirit, and exposed to solar light, it becomes red if any oil be present, but undergoes no change of colour if the spirit be pure. The following are the directions of the Edinburgh College for the application of this test:—

> "Four fluidounces [of rectified spirit] treated with 25 minims of solution of nitrate of silver [*Ph. Ed.*], exposed to bright light for twenty-four hours, and then passed through a filter purified by weak nitric acid, so as to separate the black powder which forms,—undergo no further change when again exposed to light with more of the test."

The peculiar odour which spirit obtained from brandy or whiskey possesses, depends on a volatile oil, which "is best removed, on the small scale, by rectification with a little caustic potash (Göbel, Liebig), or by digesting the spirits with freshly-ignited pine charcoal [n]."

Preparation of Proof Spirit.—The sp. gr. of proof spirit (*Spiritus tenuior*, L. E. D.) is fixed by the laws of the kingdom at 0·920 at 60° F. The Dublin College fixes it at 0·923 at 51° F., or 0·919 at 60° F. Proof spirit is usually prepared, by chemists and apothecaries, by mixing rectified spirit with water. The proportions are, Rectified Spirit [sp. gr. 0·838] Ov. [f℥xxj. *E.*; 5¼ parts, *D.*]; and Distilled Water, Oiij. [f℥xij. or a sufficiency, *E.*; 3 parts, *D.*] The tests of its goodness are the same as for rectified spirit.

Preparation of Alcohol. *Alcohol* (L. E. D.) is prepared by the chemist from the rectified spirit purchased of the rectifier. It is obtained by adding chloride of calcium, carbonate of potash, or well-burnt lime, to the spirit, which is then submitted to distillation. The salts or lime retain the water, while the alcohol distils over. The following are the directions of the British colleges :—

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[n] Turner's *Elements of Chemistry*, p. 829, 7th edit. Lond. 1840.

The *London College* orders Rectified Spirit, *Cong.* j.; Chloride of Calcium, lbj. Put the chloride of calcium into the spirit, and when it is dissolved, let seven pints and five fluidounces distil.

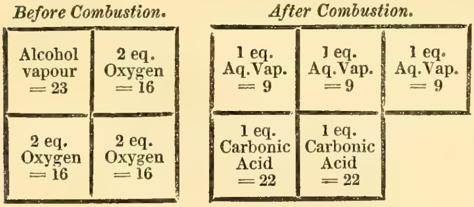
The *Edinburgh College* directs "Rectified Spirit, Oj.; Lime well burnt, ℥xviij. Break down the lime into small fragments: expose the spirit and lime together to a gentle heat in a glass matrass till the lime begins to slake: withdraw the heat till the slaking is finished, preserving the upper part of the matrass cool with damp cloths. Then attach a proper refrigeratory, and, with a gradually-increasing heat, distil off seventeen fluidounces. The density of this alcohol should not exceed 0·796: if higher, the distillation must have been begun before the slaking of the lime was finished."

The *Dublin College* takes of Rectified Spirit, *Cong.* j. [*wine measure*]; Pearl-ashes, dried, and still hot, lbiijss.; Muriate of Lime, dried, lbj. Add the pearl-ashes in powder to the spirit, and let the mixture digest in a covered vessel for seven days, shaking it frequently. Draw off the supernatant spirit, and mix it with the muriate of lime; lastly, distil, with a moderate heat, until the mixture in the retort begins to thicken. The sp. gr. of this liquor should be 0·810.

PROPERTIES OF ALCOHOL.—Alcohol is a limpid, colourless, inflammable liquid, having a peculiar and penetrating odour, and a burning taste. Its sp. gr., at 60° F., is 0·7947; at 68° F. it is 0·792—0·791. It is obvious, therefore, that the *alcohol* of the British colleges is a mixture of alcohol, properly so called, and water.

No means of solidifying it are at present known. It boils at 172° F.: every volume of the boiling liquid gives 488·3 volumes of vapour, calculated at 212° F.

It is very combustible. In atmospheric air it burns with a pale blue flame, giving out a very intense heat, and generating carbonic acid and water, but depositing no soot, unless the supply of oxygen be deficient. The colour of the flame may be variously tinted—as yellow by chloride of sodium, whitish violet by chloride of potassium, green by boracic acid or a cupreous salt, carmine red by chloride of lithium, crimson by chloride of strontium, and greenish yellow by chloride of barium.



One volume of alcohol vapour requires, for its complete combustion, three volumes of oxygen gas, and yields two volumes of carbonic acid gas and three volumes of aqueous vapour.

Alcohol has a strong affinity for water: hence it abstracts this fluid from the atmosphere, and precipitates from their watery solution those salts (*e. g.* sulphate of potash) which are not soluble in spirit: while, on the other hand, water precipitates from their alcoholic solution those substances (*e. g.* resin and oil) not soluble in water. By the mixture of alcohol and water, heat is evolved, while air-bubbles are so copiously developed, that for a few moments the liquid appears turbid. When cold, the resulting compound is found to possess a greater density than the mean of its constituents: but as the condensation varies with the proportions of alcohol and water employed, the sp. gr. of the resulting compound can be ascertained by experiment only. The maximum condensation is obtained by mixing 54 vols. of alcohol with 49·77 vols. of water: the resulting compound measures 100 vols., so that the condensation is 3·77. If we regard this as a definite compound of alcohol and water, its composition may thus be stated:—

				Rudberg.	
	Eq.	*Eq. Wt.*	*Per Cent. Wt.*	*Vols.*	*Weight.*
Alcohol	1	23	46	54·00	42·91
Water	3	27	54	49·77	49·77
Terhydrate of Alcohol	1	50	100	100·00 [condensation 3·77]	92·68

Alcohol combines with certain salts (as the chlorides and nitrates) to form definite compounds, which have been termed *alcohates,* in which the alcohol appears to act as a substitute for the water of crystallization.

Alcohol is a solvent of many organic substances, as volatile oil, fixed oil, resin, extractive, most varieties of sugar, many nitrogenous organic acids, the vegetable alkalis, urea, caseum, gliadine, leucine, picromel, and osmazome. It prevents the putrefaction of animal substances, and is, in consequence, extensively employed in the preservation of anatomical preparations. Its efficacy is imperfectly understood. It acts, in part at least, by excluding air (oxygen) and water,—the two powerful promoters of putrefaction; for when animal substances are immersed in spirit, this fluid abstracts water from the tissue which, in consequence, shrivels up, and thus prevents putrefaction, by removing one of the essential conditions to its production, namely, the presence of water. Its attraction for water, and its power of coagulating albuminous substances, are properties which probably assist powerfully in rendering it an antiseptic. Alcohol and rectified spirit of wine give greater firmness to, and whiten, the animal tissues. The latter property is objectionable in the preservation of some morbid specimens, as gelatiniform cancer (*cancer gélatiniforme* or *aréolaire* of Cruveilhier,—the *matière colloïd* of Laennec). A mixture of one part rectified spirit and three water will, however, preserve specimens of the last-mentioned disease in a transparent condition.

Characteristics.—Alcohol and ardent spirits are recognised by their inflammability, odour, taste, and miscibility with water. They dissolve camphor, resin, &c. In order to detect alcohol in liquids supposed to contain it, let the suspected liquor be submitted to distillation with a gentle heat (as from a vapour or water-bath), and to the distilled liquid add dry carbonate of potash, to abstract the water. The alcohol floats on the surface of the alkaline solution, and may be recognised by the characters above mentioned.

Composition.—The elementary constituents of alcohol are carbon, hydrogen, and oxygen.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Boullay & Dumas.*	*Saussure.*		*Vol.*
Carbon	2	12	52·18	52·37	51·98	Carbon vapour	1
Hydrogen	3	3	13·04	13·31	13·70	Hydrogen gas	3
Oxygen	1	8	34·78	34·61	34·32	Oxygen gas	0·5
Alcohol	1	23	100·00	100·29	100·00	Alcohol vapour	1

Chemists are not agreed as to the manner in which these constituents are grouped. By some, these elements are regarded as forming one equivalent of olefiant gas, and one equivalent of water; others consider alcohol to be a compound of one equivalent of a $\frac{4}{4}$ carbo-hydrogen (*etherine; tetarto-carbo-hydrogen; quadri-hydrocarburet)*, and two equivalents of water; while some view this liquid as a hydrated oxide of a $\frac{4}{5}$ carbo-hydrogen (*ethule*°*; ethereum*), or as the hydrate of the oxide of ethule. The latter opinions involve the necessity of assuming the equivalent of alcohol to be 46; that is, double the amount stated above. The following table illustrates these views:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Olefiant gas	1	14	60·7
Water	1	9	39·3
Alcohol	1	23	100·0

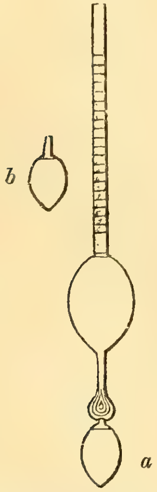
	Atoms.	*Eq. Wt.*	*Per Cent.*
Etherine	1	28	60·7
Water	2	18	39·3
Alcohol	1	46	100·0

	Atoms.	*Eq. Wt.*	*Per Cent.*
Ethule	1	29	63·04
Oxygen	1	8	17·39
Water	1	9	19·56
Alcohol	1	46	99·99

	Atoms.	*Eq. Wt.*	*Per Cent.*
Ether	1	37	80·43
Water	1	9	19·56
Alcohol	1	46	99·99

ALCOHOLOMETRY.—The value of ardent spirit is, of course, proportionate to the quantity of alcohol contained therein; and, therefore, a ready mode of estimating this is most desirable. The alcoholometrical method usually adopted consists in determining the sp. gr. of the liquid by an instrument called the *hydrometer* (from ὕδωρ, *water*; and μετρέω, *I measure*). That employed in this country, in the collection of the duties on spirits, is called *Sikes's hydrometer* (fig. 59). Spirit having the sp. gr. 0·920, at 60° F., is called *proof spirit*; that which is heavier is said to be *under proof*, while that which is lighter is called *over proof*. The origin of these terms is as follows:—Formerly a very rude mode of ascertaining the strength of spirits was practised, called the *proof:* the spirit was poured upon gunpowder, in a dish, and inflamed. If at the end of the combustion the gunpowder took fire, the spirit was said to be *above* or *over proof;* but if the spirit contained much water, the powder was rendered so moist that it did not take fire: in this case the spirit was declared to be *below* or *under proof*. As spirit of different strengths will or will not inflame gunpowder, according to the quantity of spirit employed, it became necessary to fix the legal

FIG. 59.



Hydrometer, with one of its ballast weights (*a*).
b, Another weight.

° *Ethyle*, or *ethule* (from *ether*, and ὕλη, the material or stuff from which any thing is made), is the hypothetical radical of the ethers.

value of proof spirit: this has been done, and proof spirit (*Spiritus tenuior*, Ph. L.) is defined, by act of parliament, to be such, that at the temperature of 51° F., thirteen volumes of it weigh exactly as much as twelve volumes of water. According to this definition the sp. gr. at 60° F. is 0·920, and spirit of this strength consists of

	By Weight.	*Sp. Gr.*
Alcohol	49	0·791
Water	51	1·000
Proof spirit	100	0·920

Spirit, which is of the strength of 43 *per cent. over proof* at the least, is recognised by the legislature[b] as *spirits of wine.* All spirit under this strength is known in trade as *plain spirit.* Distillers are not permitted[c] to send out spirits at any other strengths than 25 or 11 *per cent. above* or 10 *per cent. below proof.* Raw corn spirit, therefore, is sold at 25 or 11 per cent. above proof. *Compounded spirits* (as *Gin*) are not allowed[d] to be kept or sent out stronger than 17 *per cent. under proof;* but Gin, as sold by the rectifier, is usually 22 *per cent. under proof. Foreign or Colonial spirits* (not being compounded colonial spirits) must not be kept or sent out of less strength than 17 *per cent. under proof*[e]. Rum and Brandy, as commonly sold, are 10 *per cent. under proof.*

A series of carefully drawn up tables, showing the relation which exists between the sp. gr. of spirit of different strengths, and the indications of Sikes's hydrometer, is a great desideratum. Mr. Gutteridge[f] has published some tables; but several of his statements do not coincide with experiments which I have made on the subject. The following are extracts from his work:—

	SIKES'S HYDROMETER.	*Sp. Gr. at* 60° F.
Over proof.	70 per centum	0·8095
	64	0·8221
	63·1	0·8238
	62	0·8259
	61·1	0·8277
	60	0·8298
	59·1	0·8315
	58	0·8336
	57·1	0·8354
	56	0·8376
	55·9	0·8379
	55·7	0·8383
	55·0	0·8396
	54·1	0·8413
	50·1	0·8482
	43·1	0·8597
	25	0·8869
	11·1	0·9060

	SIKES'S HYDROMETER.	*Sp. Gr. at* 60° F.
	Proof	0·9200
Under proof.	5 per centum	0·9259
	10	0·9318
	11	0·9329
	15·3	0·9376
	17·1	0·9396
	20	0·9426
	22·3	0·9448
	23·1	0·9456
	25·1	0·9476
	30·1	0·9522
	40·1	0·9603
	50·3	0·9673
	60·4	0·9734
	70·1	0·9790
	80·4	0·9854
	90·2	0·9922
	100 (water)	1·0000

The sp. gr. of spirit may be readily ascertained by *Lovi's beads*, or by the *specific gravity bottle.*

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[b] 6 Geo. 4. cap. 80, Sects. 101 & 114.

[c] Ibid. Sect. 81.

[d] Ibid. Sect. 124.

[e] Ibid. Sect. 130.

[f] *The Ne Plus Ultra of Assaying, Weighing, Measuring, and Valuing of Spirituous Liquors,* vol. ii. By W. Gutteridge. London, 1828.

Table[g] *of the Specific Gravities of Mixtures of Spirit* (0·825 *at* 60° F.) *and Water at* 60° F.

Temperature 60° F.	*Sp. gr.*	*Temperature* 60° F.	*Sp. gr.*
Spirit 100 + Water 0	0·82500	Water 100 + Spirit 95	0·93247
„ 100 + „ 5	0·83599	„ 100 + „ 90	0·93493
„ 100 + „ 10	0·84568	„ 100 + „ 85	0·93749
„ 100 + „ 15	0·85430	„ 100 + „ 80	0·94018
„ 100 + „ 20	0·86208	„ 100 + „ 75	0·94296
„ 100 + „ 25	0·86918	„ 100 + „ 70	0·94579
„ 100 + „ 30	0·87568	„ 100 + „ 65	0·94876
„ 100 + „ 35	0·88169	„ 100 + „ 60	0·95181
„ 100 + „ 40	0·88720	„ 100 + „ 55	0·95493
„ 100 + „ 45	0·89232	„ 100 + „ 50	0·95804
„ 100 + „ 50	0·89707	„ 100 + „ 45	0·96122
„ 100 + „ 55	0·90144	„ 100 + „ 40	0·96437
„ 100 + „ 60	0·90549	„ 100 + „ 35	0·96752
„ 100 + „ 65	0·90927	„ 100 + „ 30	0·97074
„ 100 + „ 70	0·91287	„ 100 + „ 25	0·97409
„ 100 + „ 75	0·91622	„ 100 + „ 20	0·97771
„ 100 + „ 80	0·91933	„ 100 + „ 15	0·98176
„ 100 + „ 85	0·92225	„ 100 + „ 10	0·98654
„ 100 + „ 90	0·92499	„ 100 + „ 5	0·99244
„ 100 + „ 95	0·92758	„ 100 + „ 0	1·00000
„ 100 + „ 100	0·93002		

Another mode of judging of the strength of spirits is the phial test, technically called the *bead*; the *preuve d'Hollande* of the French. It consists in shaking the spirit in a phial, and observing the size, number, and bursting of the bubbles (or beads as they are termed): the larger and more numerous the beads, as well as the more quickly they break, the stronger the spirit.

Hitherto chemical analysis has been of little avail in determining the strength of spirit, at least for commercial purposes. For, on the one hand, we are yet in want of an accurate method of determining the relative quantities of alcohol and water in mixtures of these fluids; while, on the other, the combustion of spirit by the black oxide of copper, and the estimation of the quantity of alcohol by the carbonic acid produced, is impracticable for ordinary purposes.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Alcohol acts on plants as a rapid and fatal poison. Its effects are analogous to those of hydrocyanic acid.

β. On Animals.—Leeches immersed in spirit die in two or three minutes. Their bodies are shrivelled or contracted, and before death they make but few movements; the head and tail of the animal are drawn together. Fontana[h] found, that when half the body of a leech was plunged in spirit, this part lost all motion, whilst the other half continued in action. The same experimentalist observed, that spirit killed frogs, when administered by the stomach (in doses of 40 drops), injected beneath the skin, or when applied to the brain or spinal marrow. Plunging the heart of this animal into spirit caused its motion to cease in twenty seconds. Applied to the right crural nerve of a frog, it destroyed the power of moving in the right foot, on the application of stimulus. Monro[i] observed, that alcohol applied to the hind legs of a frog, rendered the pulsations of the heart less frequent, and diminished sensibility and mobility. Fontana[j] states, that turtles were killed by spirit administered by the stomach or by the anus, or injected beneath the skin: before death, the animal became motionless: applied to the heart of these animals it destroyed the contractility of this viscus. Some very interesting experiments were made with spirit on birds by Flourens[k]. This distinguished physiologist administered six drops of alcohol to a sparrow, whose skull he had laid bare. In a few minutes the animal began to be unsteady both in walking and flying. After some time a dark-red spot appeared on the skull, in the region of the cerebellum, and became larger and deeper-coloured in proportion as the alcohol more powerfully affected the animal. I have given alcohol to birds, but have hitherto been unable to discover the physical changes here stated. In some other experiments, Flourens observed that alcohol produced the same effects on the movements of birds as the removal of the cerebellum occasioned, but that when alcohol was administered the animal lost the use of his senses and intellectual faculties; whereas, when the cerebellum was removed, no alcohol being given, he preserved them. From these and other observations Flourens is of opinion, that alcohol, in a certain dose, acts specifically on the cerebellum, and that in larger doses it affects other parts also. Furthermore, he thinks the physical action of alcohol on the cerebellum to be absolutely the same as a mechanical lesion.

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[g] Drawn up from Gilpin's Tables in the *Philosophical Transactions* for 1792.—The spirit, which Mr. Gilpin called alcohol, was composed of 89 alcohol (sp. gr. 0·796 at 60° F.) and 11 water.

[h] *Treatise on the Venom of the Viper*, translated by J. Skinner, vol. ii. p. 371, *et seq.*

The effect of alcohol on fishes is analogous to that on other animals. If a little spirit be added to water, in which are contained some minnows (*Cyprinus phoxinus*, Linn.), the little animals make a few (spasmodic ?) leaps, and become incapable of retaining their proper position in the water, but float on their sides or back. If removed into pure water they soon recover.

The mammals, on which the effects of alcohol have been tried, are dogs, cats, horses, rabbits, and guinea-pigs. The principal experimentalists are, Courten[l], Fontana[m], Viborg[n], Brodie[o], and Orfila[p]. The results of their experiments may be thus briefly expressed:—Four drachms of alcohol, injected into the jugular vein of a dog, coagulated the blood, and caused instant death (*Orfila*). Introduced into the stomach of cats, dogs, or rabbits, it produces an apoplectic condition (*Brodie* and *Orfila*): this state is preceded, according to Orfila, by a strong excitement of the brain. The same experimentalist found that alcohol acts with less energy when injected into the cellular texture than when introduced into the stomach; from which he infers, that its first effects are the result of the action which it exerts on the extremities of the nerves; though he admits that ultimately it becomes absorbed. On examining the bodies of animals killed by introducing alcohol into the stomach, this viscus has been found in a state of inflammation.

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[i] *Essays and Observ. Physic. and Literary*, vol. iii. p. 340.

[j] *Op. cit.* p. 365, *et seq.*

[k] *Recherches sur les fonctions et les propriétés du système nerveux dans les animaux vertébrés.* Paris, 1824.

[l] *Philosophical Transactions* for 1712.

[m] *Op. supra cit.*

[n] *Abhandl. für Thierärzte*, Theil II. quoted by Wibmer, *Die Wirkung*, &c.

[o] *Philosophical Transactions* for 1811.

[p] *Toxicologie Générale.*

γ. *On Man.*—The effects of alcoholic liquors on man vary with the strength of the liquid, the substances with which the alcohol is combined, the quantity taken, and the constitution of the patient.

αα. The local effects of alcohol or *rectified spirit* are those of a powerfully irritant and caustic poison. To whatever part of the body this agent is applied, it causes contraction and condensation of the tissue, and gives rise to pain, heat, redness, and other symptoms of inflammation. These effects depend partially or wholly on the chemical influence of alcohol over the constituents of the tissues: for the affinity of this liquid for water causes it to abstract the latter from soft living parts with which alcohol is placed in contact; and when these are of an albuminous or fibrinous nature, it coagulates the liquid albumen or fibrin, and increases the density and firmness of the solid albumen or fibrin. The irritation and inflammation set up in parts to which alcohol is applied, depends (in part) on the resistance which the living tissue makes to the chemical influence of the poison: in other words, it is the reaction of the vital powers brought about by the chemical action of alcohol. But, besides the local influence of this liquid dependent on its affinity, we can hardly refuse to admit a dynamical action (*vide* p. 103), in virtue of which it sets up local irritation and inflammation, independent of its chemical agency. The coagulation of the blood contained in the vessels of the part to which this liquid is applied (an effect which Orfila observed when he killed an animal by injecting alcohol into the cellular tissue of the thigh of a dog), depends on the chemical influence of the poison.

ββ. The remote effects of ardent spirits on man may be conveniently considered in the order of their intensity; and for this purpose we may divide them into three degrees or stages[q].

1. First or mildest degree. Excitement.—This is characterised by excitement of the vascular and nervous systems. The pulse is increased in frequency, the face flushed, the eyes animated and perhaps red, the intellectual functions are powerfully excited, the individual is more disposed to joy and pleasure; cares disappear; the ideas flow more easily and are more brilliant. At this period the most violent protestations of love and friendship are frequently made; there is a strong disposition to talk, and various indiscretions are oftentimes com-

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[q] The newspaper reports of the proceedings at the Metropolitan Police Offices furnish examples of the employment, by the lower classes, of certain terms to designate the different degrees of the effects of fermented and spirituous liquors. When an individual is merely excited, he is described as *fresh;* but neither tipsy nor drunk. When the disordered intellect is just commencing, he is said to be *half seas over.* When he is beginning to be unsteady in his gait, he is described as being *tipsy.* When he reels, falls about, is incapable of standing, but is yet sensible, he is said to be *drunk.* And, lastly, when he is insensible or nearly so, he is described as *dead drunk.*—Sir Walter Scott (*Waverley*) distinguishes *fuddled* or *half seas over (ebriolus)* from *drunken (ebrius).*

mitted (*In vino veritas*). This degree of effect I presume to be the condition to which all persons aspire in drinking: the unfortunate drinks to drown his cares; the coward to give him courage; the *bon-vivant* for the sake of enjoying the society of his friends; the drunkard from mere sensuality. None, perhaps, would wish to go beyond this, yet many, when they have got thus far, exceed their intended limit.

2. SECOND DEGREE. INTOXICATION OR DRUNKENNESS.—The essential character of this stage is a disordered condition of the intellectual functions and volition; manifested by delirium, varying in its characters in different individuals, and by an incapability of governing the action of the voluntary muscles. This state is accompanied with excitement of the vascular system, and frequently with nausea and vomiting: it is followed by an almost irresistible desire for sleep, which usually continues for several hours, and is attended with copious perspiration. When the patient awakes he complains of headache, loathing of food, great thirst, and lassitude: the tongue is furred and the mouth clammy.

During a paroxysm of drunkenness, certain peculiarities are observed in the character of the delirium in different individuals. These appear to depend on what is commonly denominated temperament[r]. Mr. Macnish[s] has offered a classification of drunkards, founded on these peculiarities. He describes the *sanguineous drunkard, the melancholy drunkard, the surly drunkard, the phlegmatic drunkard, the nervous drunkard,* and *the choleric drunkard.*

3. THIRD DEGREE. COMA OR TRUE APOPLEXY.—This condition is usually observed when excessive quantities of spirit have been swallowed in a short time. According to Dr. Ogston, the patient is sometimes capable of being roused; the pulse is generally slow, the pupils are occasionally contracted, but more commonly dilated, and the breathing is for the most part slow: but exceptions exist to all these statements. Convulsions are rare: when they occur, the patients are usually young. In some cases actual apoplexy (with or without sanguineous extravasation) is brought on. The immediate cause of death appears to be either paralysis of the muscles of respiration, or closure of the glottis.—(*Vide* pp. 178 and 179.)

CONSEQUENCES OF HABITUAL DRUNKENNESS.—The continued use of spirituous liquors gives rise to various morbid conditions of system, a few only of the most remarkable of which can be here referred to. One of these is the disease known by the various names of *delirium tremens, d. potatorum, oinomania,* &c., and which is characterised by delirium, tremor of the extremities, watchfulness, and great frequency of pulse. The delirium is of a peculiar kind. It usually consists in the imagined presence of objects which the patient is anxious to seize or avoid. Its pathology is not understood. It is sometimes, but not constantly, connected with, or dependent on, an inflammatory condition of the brain or its membranes. Sometimes it is more allied to nervous fever. Opium has been found an important agent in relieving it.

Insanity is another disease produced by the immoderate and habitual use of spirituous liquors. In 110 cases of this disease, occurring in male patients admitted into the Hanwell Asylum in 1840, no less than 31 are ascribed to intemperance, while 34 are referred to combined causes, of which intemperance is stated as one. It is remarkable, however, that of 70 female patients, admitted during the same year, only four cases are ascribed to intemperance[t].

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[r] See p. 138.

[s] *The Anatomy of Drunkenness*, p. 43, 2nd ed. Glasgow, 1828.

[t] *Report of the Resident Physician* [Dr. Conolly] *of the Hanwell Lunatic Asylum presented to the Court of Quarter-Sessions at the Middlesex Sessions*, 1840.

Disease of the liver is frequently met with in drunkards, who use ardent spirits. It is generally of the kind termed, by Baillie, *common tubercle of the liver;* by Dr. Elliotson[u], the *gin liver;* by others, *granulated*, *lobulated*, *mamellated*, or *scirrhous liver.* Laennec calls it *cirrhosis* (from κιῤῥὸς, *yellowish*), in reference to its usual tawny, yellow colour. A beautiful representation of it is given by Cruveilhier[v]. Dr. Carswell[w] has described it as consisting in atrophy of the lobular structure of the liver, produced by the presence of a contractile fibrous tissue. It is not, therefore, a disease depending on the formation of a new tissue. The ascites, which so frequently accompanies it, arises from the compression to which the portal vessels are subjected by the fibrous tissue; and the jaundice, another frequent effect of it, doubtless depends on compression of the gall ducts. Some excellent remarks on this disease have been made by the late Dr. Hope[x].

Stomach affections are common results of dram-drinking. Persons addicted to the use of ardent spirits suffer with loss of appetite, and are usually dyspeptic; and chronic inflammation of the stomach, or even a scirrhous state of the pylorus, has been said to be occasionally produced by hard drinking.

Dram-drinkers are sometimes affected with *granular disease of the kidneys*, first described by Dr. Bright, and which is generally attended by albuminous urine. Dr. Hope regards this state as corresponding to the granular liver just described[y].

PECULIARITIES OF INTOXICATION FROM SPIRIT.—Different kinds of ardent spirits present some peculiarities in their operation on the system, which will be noticed hereafter (see *Brandy*, *Rum*, *Gin*, *Whiskey*, and *Arrack*).

The effects of spirit agree, in a considerable number of circumstances, with those of wine, but present some peculiarities. Spirit more speedily induces excitement, which, however, is of shorter duration, being more rapidly followed by collapse, relaxation, or debility. Death is by no means an infrequent consequence of deep intoxication from spirit. Dram-drinkers suffer usually with loss of appetite, especially in the morning, when they are troubled with vomiting. Moreover they are usually thin, wasted, and emaciated. Wine-bibbers, on the other hand, often enjoy an unimpaired appetite, and are frequently plump or corpulent, plethoric individuals. Liver disease, from intemperance, is said to be peculiar to those who take ardent spirits. Organic disease of the stomach is also a consequence of spirit drinking.

A somewhat similar distinction holds good between the effects of spirit and those of malt liquors. The latter possess nutritive properties in addition to narcotic powers: hence we frequently observe that the beer toper is a plethoric, corpulent individual[z].

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[u] *London Medical Gazette*, vol. xii. p. 484.

[v] *Anatom. Patholog.* liv. 12^{e}, pl. 1.

[w] *Pathological Anatomy*, art. *Atrophy.*

[x] *Principles and Illustrations of Morbid Anatomy.* Lond. 1834.

[y] See also Dr. Christison *On Granular Degeneration of the Kidnies*, p. 110. Edinb. 1839.

[z] Hogarth, in his *Beer Alley* and *Gin Lane*, has well represented the differences between drunkards devoted to malt liquors, and those given to the use of spirit. The first are plump, rubicund, and bloated; the latter are pale, tottering, emaciated, and miserable.

The effects of opium are readily distinguished from those of spirit when insensibility has not come on. The sleep which both these agents commonly induce is not usually preceded, in the case of opium, by delirium, thickness of voice, and peculiar difficulty of articulation. When delirium is produced by this drug (opium) it is rather of the ecstatic kind. "There is more poetry in its visions—more mental aggrandisement—more range of imagination[a]." But when insensibility is present the diagnosis is not always easy. The odour of the breath is in these cases an important diagnostic. Moreover, the pupil is usually (though not invariably) dilated by spirit, whereas it is contracted by opium.

Modus Operandi.—That alcohol becomes absorbed is proved by the fact, that it has been found in the blood, in the urine, the breath, the bile, the fluid of the serous membranes, the brain, and the liver.

Tiedemann and Gmelin[b] recognised the odour of it in the blood of the splenic vein, though they were unable to detect it in the chyle. A similar observation is reported by Magendie[c]. Dr. Percy[d] also found it in the blood of the animals to whom he had administered it. He likewise detected it in the urine and the bile. Moreover, the recognition of the odour of alcoholic liquors in the breath of individuals who have swallowed them, as well as their detection by their smell in the fluid contained in the ventricles of the brain, in the pericardium, &c., prove indisputably that alcohol becomes absorbed. Dr. Cooke[e] states, on the authority of Sir A. Carlisle, that in one case the fluid of the ventricles of the brain had the smell, taste, and *inflammability* of gin. Dr. Christison[f] has questioned the correctness of this observation, on the ground that gin of sufficient strength to take fire could not enter the blood-vessels without coagulating the blood. But the objection appears to me to be groundless; for I find that a small quantity of undiluted commercial gin may be added to white of egg without causing either coagulation or the slightest opacity. Dr. Ogston[g] has confirmed the testimony of Carlisle, and states, that in one case he found about four ounces of fluid in the ventricles, having all the physical qualities of alcohol. Dr. Percy[h] has recently set the question at rest, and satisfactorily proved the accuracy of the above statements, by his experiments on animals. He appears to think that some peculiar affinity exists between the substance of the brain and the spirit; more especially as, after analysing a much larger quantity of blood than can possibly exist in the cranium, he could generally obtain much more alcohol from the brain than from this quantity of blood. He was unable to determine whether or not the fluid of the ventricles contained any alcohol. Dr. Percy also detected alcohol in the liver, and has endeavoured to connect this fact with the frequent occurrence of hepatic disease in drunkards.

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[a] *The Anatomy of Drunkenness*, by Robert Macnish; p. 63, 2d ed. Glasgow, 1828.

[b] *Uber die Wege auf welchen Substanzen aus dem Magen ins Blut gelangen.* Heidelberg, 1820.

[c] *Element. Compend. of Physiology*, by Dr. Milligan, p. 248. 1823.

[d] *An Experimental Inquiry concerning the presence of Alcohol in the Ventricles of the Brain, after Poisoning with that liquid, together with Experiments illustrative of the Physiological Action of Alcohol.* Lond. 1839.

[e] *Treatise on Nervous Diseases*, i. 222. Lond. 1820.

[f] *Treatise on Poisons*, p. 853. 3rd ed.

[g] *Edinburgh Medical and Surgical Journal*, vol. xl.

[h] *Op. supra cit.*

Morbid Appearances.—On examining the bodies of individuals who have been poisoned by ardent spirits, redness and inflammation of the stomach are sometimes, but not invariably, found. In old drunkards the mucous membrane of the stomach is often injected and thickened. Congestion of the cerebral vessels, with or without extravasation of blood or effusion of serum, is not unfrequently observed. Traces of spirit may or may not be found in the stomach, according to the rapidity with which death has been produced. The odour of spirit may perhaps be recognised in various parts of the body, especially in the brain and the serous cavities.

Uses.—Spirit of wine is employed both for medicinal and pharmaceutical purposes.

1. *Medicinal Uses.*—Spirit is used both internally and externally:—

α. **Internally.**—Spirit of Wine is rarely administered internally; for when ardent spirit is indicated, Brandy, Gin, or Whiskey, is generally employed. The separate uses of each of these will be noticed presently: at present, therefore, I shall confine myself to some general remarks on the internal employment of spirit. I may observe, however, that Brandy is the ardent spirit usually administered for medicinal purposes; and, unless otherwise stated, is the spirit referred to in the following observations.

As a *stomachic stimulant*, spirit is employed to relieve spasmodic pains and flatulency, to check vomiting (especially sea-sickness), and to give temporary relief in some cases of indigestion, attended with pain after taking food. As a *stimulant and restorative*, it is given with considerable advantage in the latter stages of fever. As a *powerful excitant*, it is used to support the vital powers, to prevent fainting during a tedious operation, to relieve syncope and languor, and to assist the restoration of patients from a state of suspended animation. In *delirium tremens* it is not always advisable to leave off the employment of spirituous liquors at once, since the sudden withdrawal of the long-accustomed stimulus may be attended with fatal consequences. In such cases it is advisable to allow, temporarily, the patient the moderate use of the particular kind of spirit which he has been in the habit of employing. In *poisoning by foxglove and tobacco*, spirit and ammonia are used to rouse the action of the heart. In *mild cases of diarrhœa*, attended with griping pain, but unaccompanied by any inflammatory symptoms, a small quantity of spirit and water, taken warm, with nutmeg, is often a most efficacious remedy.

β. **Externally.**—Spirit of wine is used externally for several purposes, of which the following are the principal:—*As a styptic*, to restrain hemorrhage from weak and relaxed parts. It proves efficacious in two ways:—it coagulates the blood by its chemical influence on the liquid albumen and fibrin, and it causes the contraction of the mouths of the bleeding vessels by its stimulant and astringent qualities. Sponge or soft linen, soaked in spirit and water, has been applied to the mouth of the uterus in uterine hemorrhage[i]. *Spirit is used to harden the cuticle over tender and delicate parts.* Thus, brandy is sometimes applied to the nipples, several weeks before delivery, in order to prevent the production of sore nipple from suckling in individuals predisposed to it. Spirit is also applied to the feet, when the skin is readily blistered by walking. The efficacy of spirit, in hardening the cuticle, depends, in part, on its chemical influence. Spirit gargles have been found serviceable in checking the tendency to inflammation and swelling of the tonsils. *As a stimulant application,* warm rectified spirit has been applied to burned or scalded parts, on the principles laid down for the treatment of these cases by Dr. Kentish[j]. Properly diluted, spirit has been employed as a wash *in various skin diseases,* and *in ulcers of bed-ridden persons,* and as a *collyrium* in chronic ophthalmia. *Frictions with rectified spirits* have been used in the abdominal region, to promote labour pains; on the chest, to excite the action of the heart, in fainting or suspended animation; on the hypogastric region, to stimulate the bladder, when retention of urine depends on inertia, or a paralytic condition of this viscus; on various parts of the body, to relieve the pain arising from bruises, or to stimulate paralyzed parts.

The inhalation of the vapour of rectified spirit has been recommended to relieve the irritation produced by the inspiration of chlorine; but I have tried the practice on myself without benefit. The readiest mode of effecting it is to drop some spirit on a lump of sugar, and hold this in the mouth during inspiration.

Diluted spirit has been used *as an injection for the radical cure of hydrocele.* A mixture of wine and water, however, is commonly employed in this country.

Spirit has been used to form cold lotions (see p. 31). As the efficacy of it depends on its evaporation, it should be applied by means of a single layer of linen, and not by a compress. Evaporating lotions are applied,—to the head in cephalalgia, in phrenitis, in fever, in poisoning by opium, &c.; to fractures of the extremities; to parts affected with erysipelatous inflammations, &c.

ANTIDOTES.—The first object in the treatment of poisoning by spirituous liquors is to evacuate the contents of the stomach. This is best effected by the stomach-pump; emetics being frequently unsuccessful. Stimulants are then to be employed: the most effectual are the injection of cold water into the ears, cold affusion to the head and neck, warmth to the extremities, when these are cold, and the internal use either of ammonia, or of the solution of the acetate of ammonia, both of which agents have been found useful in relieving stupor. The cerebral congestion often requires the cautious employment of local blood-letting, and the application of cold to the head. If the patient appear to be dying from paralysis of the respiratory muscles, artificial respiration should be effected: if from closure of the larynx, tracheotomy may be performed (see pp. 178 and 179.)

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[i] Richter, *Ausführliche Arzneimittellehre,* 3er Bd. S. 256. Berlin, 1828.

[j] *An Essay on Burns.* Lond. 1798.—*A Second Essay on Burns.* Newcastle, 1800.

1. **SPIRITUS VINI GALLICI, L.**; *Brandy*[k]; *Eau-de-vie.*—This is an ardent spirit obtained by the distillation of wine. Its properties are subject to some variation, arising from different growths of the vine: "the brandies of Languedoc, Bordeaux, Armagnac, Cognac, Aunis, Saintonge, Rochelle, Orleans, Barcelona, Naples, &c. being each recognisable by an experienced dealer[l]." The most celebrated of the French brandies are those of Cognac and Armagnac. Genuine brandy has an agreeable, vinous, aromatic odour. Both its flavour and odour, however, are peculiar. *Pale brandy* has a very slight brownish yellow tint, derived from the cask in which it has been kept. The *high coloured brandy*, usually found in the shops of this country, is artificially coloured (before its arrival in this country) by burnt sugar (caramel); which is said to render the spirit mellow and more palatable[m]. Saunders wood is also stated, by the same authority, to be frequently used as a colouring ingredient.

The constituents of brandy are *alcohol*, *water*, *volatile oil*, a minute portion of *acetic acid*, a little *acetic ether*, *œnanthic ether*, *colouring matter*, and *tannin*. The latter is said to be derived from the cask in which the spirit has been preserved: but I find that the high coloured brandies react more powerfully on the salts of iron than pale brandy: whence I conclude that some astringent matter has been added to them.

Brandy when just imported is usually above proof. I found a sample of pale brandy, in bond, supplied me by my friend, Mr. Gassiot, to be 1·5 *over proof*; and a coloured brandy, 2·2 *over proof*, as indicated by Sikes's hydrometer. By keeping in the cask its alcoholic strength is diminished. I am informed that brandy, as usually sold, is 10 *per cent. under proof*. This would give, according to Gutteridge's table, a sp. gr. of 0·9318. But Soubeiran[n] states, that the sp. gr. of eau-de-vie varies from about 0·902 to 0·941. Now according to Gilpin's tables a spirit having the sp. gr. of 0·93002 is composed of equal parts of alcohol (sp. gr. 0·825) and water. But Mr. Brande states that 100 parts by measure of brandy, contain 53·39 parts of alcohol, sp. gr. 0·825. The relative quantities of spirit contained in this and other ardent spirits, in wine, and in beer, have been already mentioned[o].

British Brandy is extensively manufactured, and sold as foreign brandy. Dr. Ure[p] gives the following formula for it:—"Dilute the pure alcohol to the proof pitch; add to every hundred pounds weight of it from half a pound to a pound of argol (crude winestone) dissolved in water, a little acetic ether, and French-wine vinegar, some bruised

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[k] *Brandy* is a contraction for *Brandy-wine* (*Branntwein*, Germ.), which literally signifies *Burnt-wine* (*Vinum adustum*).

[l] Ure's *Dictionary of Arts and Manufactures*, p. 164. Lond. 1839.

[m] M'Culloch's *Dictionary of Commerce*.

[n] *Nouveau Traité de Pharmacie*, t. i. p. 142, 2nde éd.

[o] See p. 71 and 347.

[p] *Dictionary of Arts and Manufactures* p. 165.

French plums, and flavour-stuff from Cognac; then distil the mixture, with a gentle fire, in an alembic furnished with an agitator. The spirit which comes over may be coloured with nicely burned sugar (caramel) to the desired tint, and roughened in taste with a few drops of tincture of catechu or oak-bark."

Acrid matters (as Grains of Paradise) are sometimes added to brandy to give it an artificial strength. They may be readily detected by evaporation. Sugar, also, may be discovered in the same way. The residue of the evaporation of genuine brandy yields a green colour with the salts of iron, indicating the presence of tannin: and imitation brandy may be readily made to produce the same effect, by the addition of catechu, or some other astringent.

The general effects and uses of brandy are those of alcohol already described. From the ardent spirits in ordinary use it is distinguished by its cordial and stomachic properties; and it is, in consequence, the stimulant usually preferred for medicinal purposes.

Burnt Brandy is a popular remedy for diarrhœa.

2. **MISTURA SPIRITÛS VINI GALLICI,** L. (Brandy, Cinnamon Water, of each, f℥iv.: the yolks of two Eggs; Purified Sugar, ℥ss; Oil of Cinnamon, ♏ij. Mix.)—This mixture is an imitation of a well-known compound, termed *Egg-Flip*[q]. It is an exceedingly valuable stimulant and restorative; and is employed in the latter stages of low fever, and in extreme exhaustion from uterine and other hemorrhages. The dose of it is from f℥ss. to f℥iss.

3. **SPIRITUS SACCHARI**; *Rum.*—This is an ardent spirit obtained both in the West and East Indies, by distillation from the fermented skimmings of the sugar boilers, the drainings (called *molasses*) of the pots and hogsheads of sugar, the washings of the boilers[r], and the lees or spent wash of former distillations, called *dunder*[s]. It is imported into this country in puncheons. In some parts of the West India islands it is customary to put slices of pine-apples in the puncheons of rum: hence the designation *pine-apple rum.*

The term *Tafia*, or *Taffia*, is applied to a spirit obtained, by distillation, from the fermented juice of the sugar-cane[t]. It is, therefore, *Cane Spirit* (*Spiritus Succi Sacchari*).

Good rum is transparent and of a brownish tint. Its depth of colour, however, varies considerably. The peculiar flavour of rum depends on *volatile oil.* The quantity of *alcohol* (sp. gr. 0·825) in 100 vols. of rum is, according to Mr. Brande, about 53·68 vols. As sent out, its strength is 10 *per cent. under proof*, in the language of Sikes's hydrometer. *Jamaica rum* is more highly esteemed than the *Leeward Islands rum.*

The general effects and uses of rum are similar to those of alcohol already described [u]. It is considered more heating and sudorific than the other kinds of ardent spirit, to which it has been popularly thought preferable in coughs, catarrhs, and rheumatism.

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[q] The terms *Egg-flip*, *Egg-hot*, or simply *Flip*, are applied to a preparation of ale with egg and ardent spirit (see Dr. Kitchener's *Cook's Oracle*).

[r] *The Civil and Natural History of Jamaica*, by P. Browne, M.D., p. 132. Lond. 1789.

[s] Dunder, from the Spanish *redundar*, to overflow.

[t] Merat and De Lens, *Dict. de Mat. Méd.* t. vi. p. 150.

4. **SPIRITUS FRUMENTI COMPOSITUS**; *Compound Corn Spirit.*—The spirit manufactured in British islands is usually obtained by distillation from fermented infusions of corn. The ardent spirits known as *Gin*, *Whiskey*, and the various *Compounds* [v], are corn spirit differently flavoured.

Gin owes its peculiar flavour to the Juniper, whence it is frequently denominated *Spiritus Juniperi.* It is not allowed to be sent out stronger than 17 *per cent. under proof;* but it is usually sold to the trade at 22 *per cent. under proof.* The retail dealer always reduces its strength, and flavours it with sugar. Frequently also other additions are made to it. Gin possesses the general properties of alcohol. On account of the oil of juniper which it holds in solution, it is more powerfully diuretic than brandy and rum; and hence it is a popular remedy in dropsical and other affections, where an augmentation of the renal secretions is considered desirable. Moreover, it is frequently used to promote menstruation. It is the ordinary intoxicating spirit of the lower classes in this metropolis. At the London Hospital, gin is frequently administered medicinally, as a substitute for brandy, to patients who have been accustomed to its use.

Whiskey agrees in most of its properties with gin; from which it differs in its peculiar smoky flavour and odour: these it acquires from the malt, which is dried by turf fires. It is the national spirit of Ireland and Scotland.

5. **ARRACK**, or **RACK.**—This is a spirit obtained in various parts of the East. In Batavia, it is procured by distillation from fermented infusions of rice, whence it has been termed *Rice Spirit* (*Spiritus Oryzæ*). In Ceylon [w], it is obtained by distillation from fermented cocoa-nut toddy (by some called *Palm wine*).

"Pine apples, steeped in it, impart a most exquisite flavour to the

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[u] "They talk of a common experiment here [Jamaica], that any Animal's Liver put into Rum grows soft, and not so in Brandy, whence they argue this last less wholesome than that, but their Experiment, if true, proves no such thing. I think it may be said to have all good and bad qualities of Brandy, or any fermented or vinous spirit."—(Sloane's *Jamaica*, vol. i. p. xxx. Lond. 1707.)

[v] By spirit dealers, British compounded spirits are denominated *Compounds*, while Foreign compounded spirits are called *Liqueurs.* Both class of liquors are sweetened spirits.

The following list of Compounds, usually kept at the gin-shops of this metropolis, has been supplied me by the proprietor of one of these establishments:—

Compounds.	*Under Proof.*	*Compounds*	*Under Proof.*
Gin	17	Tent	"
Gin	22	Aniseed	"
Mint *(Peppermint)*	64	Caraway	"
Cloves	"	Lovage	"
Bitters	"	Usquebaugh (X)	"
Raspberry	"	Rum Shrub	"
Noyeau	"	Orange Cordial (X)	"
Cinnamon	"	Citron ditto (X)	

"The above are permitted to us at the strengths named; but, in point of fact, are much nearer approaching 80 U. P.—Those marked thus (X) are seldom asked for."

[w] *The Coco-Nut Palm, its Uses and Cultivation.* By J. W. Bennett, Esq. Lond. 1836.

spirit; and, by age, it becomes a delicious liqueur, which is unrivalled in the world for making nectarial punch." In England, arrack is never employed for medicinal purposes. In its general properties it agrees with the other ardent spirits; but is said to be distinguished by its stimulating and narcotic properties. It is sometimes used in this country to impart an agreeable flavour to *punch*. A mock arrack is made by dissolving twenty grains of benzoic acid in two pounds of rum.

2. *Pharmaceutical Uses of Alcohol.*—The alcohol of the Pharmacopœia (sp. gr. 0·815) is not employed in the preparation of any officinal substances, but it is a valuable agent in chemical analysis, and is used in determining the purity of certain medicinal substances; as iodine, iodide of potassium, the vegetable alkalis, castor oil, &c. Rectified and proof spirits are most extensively employed in officinal pharmacy: as in the formation of *Tinctures*, *Spirits*, *Ethers*, *Etherial Oil*, and *Resinous Extracts*, and in the manufacture of the *Vegetable Alkalis*. Lastly, spirit is added to various preparations to assist in preserving them.

1. **TINCTURÆ**, L. D.; *Tinctures*, E.; *Alcoolés.*—These are solutions of vegetable, animal, or mineral substances, in proof or rectified spirit. They are preparations of substances whose active principles are imperfectly or not at all soluble in water, or whose aqueous solutions readily undergo decomposition.

Some are prepared by *solution* merely; as the *Tinctura Iodinii composita*, Ph. L.; *Tinctura Camphoræ*, Ph. Ed.; and *Tinctura Ferri Sesquichloridi*.

Some of the vegetable tinctures are prepared by adding rectified spirit to the expressed juices of plants. These preparations are frequently denominated *preserved vegetable juices*. They have been long in use on the continent. In 1835, Mr. Squire[x] commenced their manufacture. More recently, Mr. Bentley[y] has directed the attention of the profession to them.

Mr. Squire states, that on an average the juice of the young plant just coming into flower, will yield only two-thirds of the amount of extract which is obtained from the same quantity of juice from the matured plant ("when more than half the flowers are fully blown"), and the strength of the product is also inferior. He also asserts[z] that the leaves only should be used: and in the case of biennial plants, those of the second year's growth should exclusively be employed[a].

The mode of obtaining these preparations is as follows:—The leaves being bruised in a marble mortar, are placed in a powerful press. The expressed juice is allowed to stand for twenty-four hours, by which a considerable quantity of feculent matter is deposited. Rectified spirit [56 over proof] is then added, in the proportion of four fluidounces to every sixteen fluidounces of the juice, which is quite sufficient to render the preservation complete, and throw down any mucilage which may be mechanically suspended. After standing for twenty-four hours the liquor is be filtered[b].

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[x] *Pharmaceutical Transactions*, No. iii. p. 94. Sept. 1841.

[y] *On the Best Method of obtaining the more powerful Vegetable Preparations for Medical Use.*

[z] *Op. supra cit.*

[a] See the article *Hyoscyamus*, for an account of the relative quantities of juice and extract yielded by the leaves and stalks.

Mr. Squire employs one measure of spirit to two measures of juice.

These preserved expressed juices are superior preparations to the tinctures prepared by digestion from the same parts of either fresh or dried plants. In some cases (*e.g.* Aconite), tinctures prepared with rectified spirit from the dried roots, by digestion, are greatly superior in activity to the preserved juices of the leaves.

The ordinary method of preparing tinctures is by *maceration* or *digestion.*

"Tinctures are usually made by reducing the solid ingredients to small fragments, coarse powder, or fine powder, macerating them for seven days or upwards in proof spirit or rectified spirit, straining the solution through linen or calico, and finally expressing the residuum strongly to obtain what fluid is still retained in the mass."—*Ph. E.*

All Tinctures should be prepared in stoppered glass vessels, and frequently shaken during maceration.—*Ph. Lond.*

The tinctures which are made with resinous substances cannot in general be well prepared in any other way than by digestion. This remarks applies to *Tinctura Aloes*, *Tinctura Asafœtidæ*, *Tinctura Benzoini composita*, *Tinctura Guaiaci*, and *Tinctura Balsami Tolutani.*

Another and more expeditious method of preparing tinctures is by *percolation* or *lixiviation (procédé ou méthode de déplacement)*; and which is also applicable to the preparation of etherial, as well as alcoholic, tinctures, and of infusions. The principle of this method has been adopted by the Scotch brewers; the process being called by them *sparging.* It has also been used in the preparation of coffee. It was first employed for pharmaceutical purposes by Boullay[c]. In the preparation of tinctures its professed advantages are expedition, economy, and uniformity of strength. But it is more troublesome, requires more skill and attention, and is not equally applicable to all substances. It answers best for those tinctures made with woody and fibrous parts, as roots, barks, woods, leaves, fruits, seeds, and insects. The Tinctures of Catechu and Myrrh may also be prepared in this way. The *Edinburgh College* offers the following remarks on this mode of preparation:—

"A much superior method, however, has been lately introduced, which answers well for most tinctures, namely, the method of displacement by percolation. According to this process, the solid materials, usually in coarse or moderately fine powder, are moistened with a sufficiency of the solvent to form a thick pulp. In twelve hours, or frequently without any delay, the mass is put into a cylinder of glass, porcelain, or tinned iron, open at both ends, but obstructed at the lower end by a piece of calico or linen, tied tightly over it as a filter; and the pulp being packed by pressure, varying as to degree with various articles, the remainder of the solvent is poured into the upper part of the cylinder, and allowed gradually to percolate. In order to obtain the portion of the fluid which is kept in the residuum, an additional quantity of the solvent is poured into the cylinder, until the tincture, which has passed through, equals in amount the spirit originally prescribed: and the spirit employed for this purpose is then recovered for the most part by pouring over the residuum as much water as there is of spirit retained in it, which may be easily known by an obvious calculation in each case. The method by percolation, where applicable, will be found much more convenient and expeditious than the mode hitherto commonly followed, and it exhausts the solid materials in general much more completely. As considerable practice, however, is required for managing the details in different cases, more especially in regard to the degree of firmness with which they are to be packed in the cylinder, we have thought it right to direct that the method of maceration, may be followed as an alternative. But the method of percolation is now preferred by all who have made sufficient trial of it to apply it correctly."

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[b] Bentley, *op. supra cit.*

[c] *Journal de Pharmacie,* t. xix. p. 393.

The percolator is best made of tin plate or zinc. A simple tube (of glass, porcelain, or tinned iron), as stated by the Edinburgh College, answers for an extemporaneous percolator. It is fitted into the mouth of a wide-mouthed bottle by means of a cork (fig. 60), in which is a small aperture to allow of the escape of air. One of the most convenient percolators is that proposed by Boullay. It is a simple cylinder of equal diameter, and terminating inferiorly in a cone or funnel. Mr. Deane's percolator[d] (fig 61) is a modification of this: its lower end, C D, has a smaller circumference than its upper one, A B; is flat, and communicates with a tube, to which a stop-cock is fitted. Soubeiran[e] has adapted to Boullay's percolator a tin receiver, to which is fitted, at the most depending part, a stop-cock, by which the tincture may be drawn off (fig. 62).

Fig. 60.

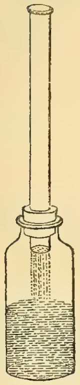


Fig. 61.

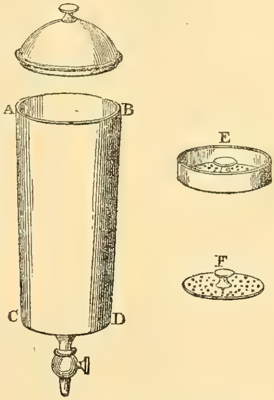
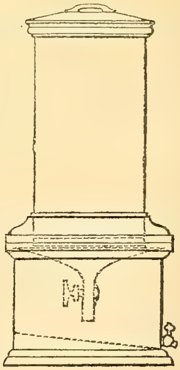


Fig. 62.



Tincture Percolators.

The size of the percolator must, of course, vary according to circumstances. The smallest may be half an inch in diameter and four inches long. Large ones are six inches in diameter and eighteen inches long. They should be furnished with two diaphragms (perforated metallic disks, fig. 61, E, F), between which the ingredients are placed. When small percolators are used, a little cotton-wool, or even tow, may be substituted for the lower diaphragm,—or a piece of calico or linen may be tied over the end of the tube, as directed by the Edinburgh College. The lower extremity of the percolator should be furnished with a stop-cock (see figs. 61 and 62), for regulating the discharge of the fluid.

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[d] *Pharmaceutical Transactions*, part ii.
[e] *Nouveau Traité de Pharmacie*, t. i. p.iii. 2nde éd.

Considerable skill and experience are required in packing the ingredients. Indeed, the principal art of percolating has reference to this part of the process. Substances, as Rhubarb and Gentian, which yield a large quantity of mucilage, and are to be acted on by water, must be employed in the form of a very coarse powder, and should be placed loosely in the percolator, in order to allow them to swell. With alcohol or ether, however, the tissues swell less, the mucilaginous matter is not dissolved, and the percolation is readily effected even with a finer powder and closer packing.

Boullay imagined that one liquid may be employed to displace another liquid, without the two liquids becoming mixed: hence he called the process the *displacement method.* The Edinburgh College, I presume, has adopted his opinion, since it directs the tincture to be displaced by spirit, and the spirit by water. But Guilliermond[f] has shown that this displacement cannot be effected without a certain degree of mixture[g].

2. **SPIRITUS**, L. D. *Spirits*, E. *Alcoolats.*—These are alcoholic solutions of volatile substances (usually of a vegetable nature) obtained by distillation. Some of them are prepared with rectified spirit (e. g. *Spiritus Rosmarini*), but most of them with proof spirit. Several of the spirits which owe their peculiar flavour and odour to volatile oil may be, and usually are, imitated by dissolving the oil in the spirit without the aid of distillation; and, for all therapeutical purposes, they are equally effective.

2. Æ'THER SULPHU'RICUS, *L. E. D.*—SULPHURIC ETHER.

History and Synonymes.—This liquid is said to have been known to Raymond Lully[h], who lived in the 13th century; and to Basil Valentine[i], in the 15th century. In 1540, Valerius Cordus[j] described the method of making it. He termed it *Oleum Vitrioli dulce.* The Germans call it *Vitriolic Naphtha* (*Naphtha Vitrioli*).

Natural History.—It is always an artificial product.

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[f] *Journal de Pharmacie*, t. xxi. p. 349.

[g] For further details respecting percolation, consult, besides the memoirs already quoted, Dausse, *Mémoire sur la preparation de tous les extraits pharmaceutiques, par la méthode de déplacement.* Paris, 1836.

[h] Dulk, *Die Preussische Pharmakopöe übers und erläutert*, 2er Th. S. 201. 2te Aufl. Leipz. 1830.

[i] Ibid.

[j] Thomson, *System of Chemistry*, vol. ii. p. 296. 7th ed. 1831.

PREPARATION.—All the British Colleges give directions for the preparation of sulphuric ether.

The *London College* orders of Rectified Spirit, lbiij.; Sulphuric Acid, lbij.; Carbonate of Potash, previously ignited, ℥j.: pour two pounds of the spirit into a glass retort, add the acid to it, and mix. Afterwards place it on sand, and raise the heat so that the liquor may quickly boil, and the Ether pass into a receiving vessel cooled with ice or water. Let the liquor distil until some heavier portion begins to pass over. To the liquor which remains in the retort, after the heat has subsided, pour the remainder of the spirit, that ether may distil in the same manner. Mix the distilled liquors, then pour off the supernatant portion, and add to it the Carbonate of Potash, shaking them frequently during an hour. Lastly, let the ether distil from a large retort, and be kept in a stoppered vessel.

The directions of the *Edinburgh College* are as follows:—"Take of Rectified Spirit, f℥L.; Sulphuric Acid, f℥x. Pour twelve fluidounces of the spirit gently over the acid contained in an open vessel, and then stir them together briskly and thoroughly. Transfer the mixture immediately into a glass matrass connected with a refrigeratory, and raise the heat quickly to about 280°. As soon as the etherial fluid begins to distil over, supply fresh spirit through a tube into the matrass in a continuous stream, and in such quantity as to equal that of the fluid which distils over. This is best accomplished by connecting one end of the tube with a graduated vessel containing the spirit, passing the other end through a cork fitted into the matrass,—and having a stop-cock on the tube to regulate the discharge. When forty-two ounces have distilled over, and the whole spirit has been added, the process may be stopped. Agitate the impure ether with sixteen fluidounces of a saturated solution of muriate of lime, containing about half an ounce of lime recently slaked. When all odour of sulphurous acid has been thus removed, pour off the supernatant liquor, and distil it with a very gentle heat, so long as the liquid which passes over has a density not above 0·735. More ether of the same strength is then to be obtained from the solution of muriate of lime. From the residuum of both distillations, a weaker ether may be obtained in small quantity, which must be rectified by distilling it gently again."

The *Dublin College* directs Sulphuric Ether to be prepared from the *Liquor Æthereus Sulphuricus*, which is ordered to be made thus:—Take of Rectified Spirit, Sulphuric Acid, of each ℥xxxij. *by weight.* Pour the spirit into a glass retort adapted to bearing a sudden heat, and then pour on the acid in an unbroken stream; mix them gradually, and let twenty ounces *by measure* of the liquor be distilled with a sudden and sufficiently strong heat, into a receiver kept cold. If sixteen ounces of rectified spirit be poured upon the acid remaining in the retort, sulphuric ethereal liquor will again come over by distillation.

Take of this Sulphuric Ethereal Liquor, f℥xx.; Carbonate of Potash, dried and powdered, ʒij. Mix them, and, from a very high retort, distil, by a very gentle heat, twelve ounces *by measure* into a receiver kept cold. The sp. gr. of the liquor should be to that of distilled water as 0·765 to 1·000.

THEORY OF ETHERIFICATION.—In order to convert two equivalents or 46 parts of alcohol into one equivalent or 37 parts of ether, we must abstract one equivalent or 9 parts of water.

	Carbon.	*Hydrogen.*	*Oxygen.*
2 equivalents Alcohol are composed of	4 eq.	6 eq.	2 eq.
Abstract 1 equivalent Water composed of	0 eq.	1 eq.	1 eq.
1 equivalent Ether	4 eq.	5 eq.	1 eq.

But, though the change thus far appears very simple, there are some accessory reactions which make the theory of etherification exceedingly complicated, and about the precise nature of which chemists are not quite agreed.

That the sole or efficient cause of the conversion of alcohol into ether is not the mere abstraction of the water, by the affinity of the sulphuric acid for that liquid, is proved by various circumstances, of which the following are some[k]:—

α. Water may be abstracted from alcohol by alkalis and chloride of calcium, yet nothing like ether is the result.
β. Water passes over, during the whole process, along with the ether, with which the acid ought to combine in preference to dehydrating the alcohol.
γ. Ether is not produced by the action of anhydrous sulphuric acid on alcohol.
δ. Ether is never produced except by the aid of heat.
ε. When the oil of vitriol is mixed with rectified spirit, the saturating power of the acid is diminished.

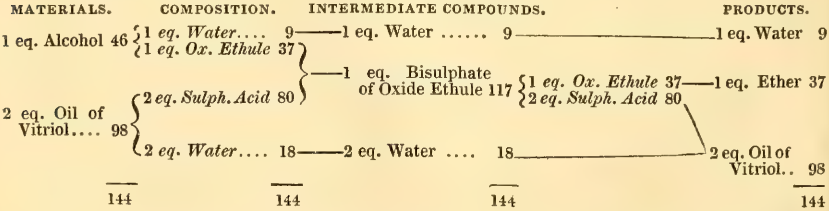
When oil of vitriol is added to rectified spirit, a new compound is formed, which contains, besides the elements of sulphuric acid, carbon, hydrogen, and oxygen.

As this new compound reddens litmus, and forms salts with bases, it has been regarded as an acid (*sulpho-vinic acid*[l]; *ethereo-sulphuric acid*[m]). But as the sulphuric acid, by its union with the elements of the alcohol, has lost half its saturating power, the new compound is rather to be regarded as a supersalt (*bisulphate of the oxide of ethule*[n]), combined with water; or as a double salt composed of sulphate of the oxide of ethule and sulphate of water. Carbo-hydrogen is the basic constituent of this salt, which, by the action of heat, is resolved into ether, sulphuric acid, and water.

On the ethule hypothesis, so ably advocated by Liebig, the following is an explanation of the changes attending the formation of ether:—

Alcohol is regarded as the hydrate of the oxide of ethule, and its equivalent is assumed to be 46. On the addition of oil of vitriol, two equivalents or 80 parts of anhydrous sulphuric acid combine with one equivalent or 37 parts of oxide of ethule (*ether*), contained in the alcohol, and form one equivalent or 117 parts of bisulphate of oxide of ethule (*bisulphate of ether*). The water of the alcohol and of the oil of vitriol unites with the bisulphate. By the heat, which is subsequently applied to the mixture, the hydrated bisulphate is resolved into ether, water, and sulphuric acid.

In the following diagram, the oil of vitriol ($SO^3 + HO$) is assumed to be the strongest procurable, and the alcohol to be uncombined with water:—



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[k] Brande, *Manual of Chemistry*, p. 1284, 5th ed. 1841.
[l] Hennell, *Philosoph. Trans.* 1826 and 1828.
[m] Liebig, in the *Handwörterbuch der reinen und angewandten Chemie*, von Dr. J. Liebig and Dr. T. C. Poggendorf, Bd. i. S. 114. Braunschweig, 1837.
[n] Liebig, in Turner's *Elements of Chemistry*, p. 837, et seq. 7th ed. 1840.

"If we consider each particle of the [hydrated] bisulphate of oxide of ethule as composed of ether [oxide of ethule], anhydrous sulphuric acid, and water, it is clear that the anhydrous acid, at the moment of its separation from the ether, must seize on all water, free or combined, in the vicinity of the ether. Thus, at the moment the ether becomes free, the anhydrous acid, also set free, prevents it from uniting with water to form alcohol. But when the gaseous ether passes through the undecomposed hydrated bisulphate of oxide of ethule, a certain proportion of the water of that compound must evaporate in the dry gas; and in these circumstances the ether and water do not combine together. The surface of the effervescing liquid has the temperature at which [hydrated] bisulphate of oxide of ethule is decomposed; but at this temperature, 284°, the water of that compound is gaseous. There are thus produced, simultaneously, water in the gaseous form by evaporation, and ether, also gaseous, by decomposition; which, as both are in the nascent state, unite to form alcohol. Thus the alcohol, always observed to distil over with the ether, is derived from the surface; and the ether and water, which distil over, proceed from the decomposition in the interior of the liquid. This explains why no ether is obtained when the liquid is not in brisk ebullition, no matter how high the temperature may be; it explains further, why more alcohol is obtained when a current of dry air passes through the liquid, since in that case the same decomposition goes on in the interior of the liquid as generally occurs at the surface.[°]"

During the distillation of ether the relative proportions of the ingredients are constantly varying; for the absolute quantity of hydrated bisulphate of ethule is continually diminishing, and thereby the relative quantity of oil of vitriol is increasing. In consequence of this, the boiling point of the liquid gradually rises. When it arrives at about 320°, new reactions take place between the oxide of ethule and the sulphuric acid. The principal products of these reactions are sulphurous acid, olefiant gas, water, and carbon. The subjoined diagram will explain how these are produced from the bisulphate of oxide of ethule:—

MATERIAL.	COMPOSITION.		RESULTS.
1 eq. Bisulphate of Oxide Ethule 117	2 *eq. Sulphuric Acid* 80	2 *eq. Sulphurous Acid* 64	3 eq. Sulphurous Acid 64
		2 *eq. Oxygen* 16	3 eq. Water . 27
	1 *eq. Oxygen* 8		
	1 *eq. Ethule* 29	3 *eq. Hydrogen* 3	
		2 *eq. Hydrogen* 2	1 eq. Olefiant gas 14
		2 *eq. Carbon* 12	
		2 *eq. Carbon* 12	2 eq. Carbon 12
117		117	117

These are not the only products of the reaction above referred to. In certain proportions of the ingredients, acetic acid [$C^4 H^3 O^3$] is formed. "With a great excess of [sulphuric] acid, traces of formic acid [$C^2 H^1 O^3$] and carbonic oxide are produced. As long as olefiant gas comes off, carbonic acid cannot be detected. During this decomposition, sulphurous acid and olefiant gas are given off in equal volume." "Carbon and water are the elements of acetic acid, the formation of which must diminish the quantity of carbon in the residue. By the action of the sulphuric acid in excess on acetic acid, formic acid and sulphurous acid are formed; and by the action of the sulphuric acid in excess on formic acid, carbonic oxide gas is

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[°] Liebig, in Turner's *Elements of Chemistry*, p. 841, 7th ed.

produced[p]." "It is probable that in this decomposition, the elements of sulphuric acid and of ether first arrange themselves so as to form ethionic [$4\,SO^3$, $C^4\,H^5\,O$] or isethionic [$S^2\,O^5$, $C^4\,H^5\,O^2 + aq.$] acids." A small quantity of Light Oil of Wine is also produced. In the directions for the preparation of ether, given by the London College, the process is directed to be stopped when some "heavier portion" begins to pass over. This heavier liquid is an aqueous solution of sulphurous acid.

On the small scale ether may be readily made in a tubulated glass retort, connected by Liebig's condensing tube, with a cooled glass receiver. At Apothecaries' Hall, London, it is made in a leaden still, having a pewter head connected by about six feet of tin pipe with a very spacious condensing worm, duly cooled by a current of water; the receivers are of pewter with glass lids, and have a side tube to connect them with the delivering end of the worm-pipe. The still is heated by high-pressure steam carried through it in a contorted leaden pipe. A tube enters the upper part of the still for the purpose of suffering alcohol gradually to run into the acid[q].

Mitscherlich[r] has shown how a given quantity of oil of vitriol may be made to convert an unlimited quantity of alcohol into ether; the whole of the alcohol which enters the retort passing off as ether and water. As, however, ether is usually prepared from hydrated alcohol (rectified spirit) the superfluous water gradually dilutes the acid until ultimately it becomes too dilute to effect the conversion of alcohol into ether. The process of the Edinburgh Pharmacopœia is an imitation of Mitscherlich's principle.

The rectification of ether is intended to free it from alcohol, water, sulphurous acid, and oil of wine. It is ordered to be effected by the addition of carbonate of potash and re-distillation. In order to separate alcohol from ether, the readiest method is to shake the ether with twice its bulk of water; then pour it off, and remove the water, which the washed ether has dissolved, by adding some fresh burned lime, and distilling the ether a second time.

PROPERTIES.—At ordinary temperatures ether is a colourless, very limpid liquid, having a penetrating, peculiar, though somewhat fragrant odour; a hot, pungent taste, and a high refractive power. It is a bad conductor of electricity. Absolutely pure ether has not been solidified by any degree of cold hitherto produced. (Thenard and Bussy). I have submitted it to the action of solid carbonic acid (whose temperature was probably 148° below the zero of Fahrenheit), without freezing it. But Fourcroy and Vauquelin, and more recently Liebig, state that it may be frozen at 46° below zero. The sp. gr. of pure ether at 68° F. is, according to Dumas and Boullay, 0·713. The ether of the shops contains a little alcohol, and its sp. gr. varies from 0·733 to 0·765: in the London Pharmacopœia its sp. gr. at 62° F. is fixed at 0·750. Ether is extremely volatile: when of sp. gr.

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[p] Liebig, *op. supra cit.*

[q] Brande's *Manual of Chemistry*, p. 1275, 5th ed. 1841.

[r] *Lehrbuch der Chemie*, 1er Band, S 98, 2te Aufl. Berlin, 1833.

0·720, its boiling point (the mercury in the barometer standing at 30 inches), is about 98° F. In a vacuum, it boils at 40° F. below zero. The evaporation of ether causes intense cold. The sp. gr. of ether-vapour was found, by Gay-Lussac, to be 2·586. Pure and recently prepared ether possesses neither acid nor alkaline properties; but, by exposure to air and light, it absorbs oxygen, by which acetic acid and water are produced. The acetic acid is not immediately observed, because it combines with some undecomposed ether to form acetic ether.

Ether is very combustible: it burns in atmospheric air with a yellowish-white flame, and forms carbonic acid and water. Its vapour, mixed with oxygen or atmospheric air, forms a violently explosive mixture. The house of an apothecary at Bern was blown up, in consequence of a lighted candle being taken into a cellar in which a bottle of ether had been broken. One volume of ether vapour consumes, in burning, six volumes of oxygen gas: the products are, four volumes of carbonic acid, and five volumes of aqueous vapour. By the slow combustion of ether vapour, by means of a coil of platinum wire, acetic, formic, and lampic [aldehydric] acids are produced.

Before Combustion.

1 eq. Ether Vap. = 37	2 eq. Oxygen = 16	2 eq. Oxygen = 16	2 eq. Oxygen = 16
2 eq. Oxygen = 16	2 eq. Oxygen = 16	2 eq. Oxygen = 16	

After Combustion.

1 eq. Carb^{c} Acid = 22	1 eq. Carb^{c} Acid = 22	1 eq. Aq. Vap. = 9	1 eq. Aq. Vap. = 9	1 eq. Aq. Vap. = 9
1 eq. Carb^{c} Acid = 22	1 eq. Carb^{c} Acid = 22	1 eq. Aq. Vap. = 9	1 eq. Aq. Vap. = 9	

Ether is sparingly soluble in water: nine volumes of the latter dissolve one of the former. Ether, which has been washed with water, contains a small portion of the latter liquid. Alcohol dissolves ether in all proportions.

Ether abstracts bichloride of mercury, terchloride of gold, and the sesquichloride of iron, from their watery solutions. It readily dissolves bromine and iodine; but the solutions, by keeping, undergo decomposition. It sparingly dissolves sulphur and phosphorus: the ethereal solution of phosphorus is luminous in the dark, when poured on hot water. It dissolves the volatile oils, most of the fatty and resinous substances, some of the vegetable alkalis, urea, and osmazome

Characteristics.—Sulphuric ether may be recognised by its combustibility, its yellowish white flame, its volatility, its peculiar odour and taste, its complete solubility in alcohol, and its sparing solubility in water, in consequence of which, when mixed with water and agitated in a phial, the mixture speedily separates, on standing, into two layers. It dissolves most resins: the solutions, evaporated on the surface of water, leave a resinous film.

Composition.—The following is the elementary composition of ether:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Dumas & Boullay.*
Carbon	4	24	64·87	65·05
Hydrogen	5	5	13·51	13·85
Oxygen	1	8	21·62	21·24
Ether	1	37	100·00	100·14

Chemists are not agreed as to the manner in which these elements are associated. Ether has been considered, at different times, as a *dihydrate of olefiant gas*,—a *hydrate of etherine*,—or as the *oxide of ethule* (ethereum).

2 eq. Olefiant gas	28	1 eq. Etherine	28	1 eq. Ethule	29
1 eq. Water	9	1 eq. Water	9	1 eq. Oxygen	8
1 eq. Dihydrate of Olefiant gas	37	1 eq. Hydrate of Etherine	37	1 eq. Oxide of Ethule	37

In this table olefiant gas is regarded as a $\frac{2}{2}$ carbo-hydrogen, etherine as a $\frac{4}{4}$ carbo-hydrogen, and ethule as $\frac{4}{5}$ carbo-hydrogen.

PURITY.—The ether of commerce is usually contaminated with small quantities of either spirit or water, or both. These augment its sp. gr. but do not much affect its medicinal properties. The London College states that its sp. gr. should be 0·750; but this is too high. The Edinburgh College fixes it at 0·735, or under. I think 0·740 would be sufficiently low. Ether which contains no alcohol does not coagulate the serum of the blood. Pure ether does not redden litmus, but the ether of the shops usually does so slightly, either from being imperfectly prepared or being too long kept. Ten fluidounces of water should not dissolve more than one fluidounce of ether, and the solution should be quite transparent. It should speedily and totally evaporate in the air. It should not become milky when mixed with water. "When agitated in a minim measure, with half its volume of concentrated solution of muriate of lime, its volume is not lessened," *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Ether, like alcohol, acts as a powerful and rapid poison to plants.

β. On Animals.—The effects of it on dogs have been determined by Orfila[s], who found that half an ounce introduced into the stomach, and the œsophagus tied, caused attempts to vomit, diminished muscular power, insensibility, and death in three hours. Three drachms and a half injected into the cellular tissue of the thigh, caused death on the fourth day. Jäger[t] found that half an ounce of ether acted as a fatal poison to a crane: at the end of forty-eight hours its odour could be readily detected in the body. He made similar experiments with pigeons and ducks. One of the last-mentioned animals took altogether an ounce of ether, yet was not dead at the end of twenty-four hours.

γ. On Man.—The operation of ether is analogous to that of alcohol, but is much more rapid and transient. *Swallowed in moderate doses* it makes a powerful impression on the mouth, throat, and stomach; allays spasm, and relieves flatulence: but, according to some observers, it augments neither the heat of the body nor the frequency of the pulse [u]. Its first effects on the cerebral functions are those of an excitant, but the subsequent ones are those of a depressing agent. *In somewhat larger doses* it produces intoxication like that caused by alcohol. *In excessive doses* it occasions nausea, a copious flow of saliva, giddiness, and stupefaction.

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[s] *Toxicolog. Générale.*

[t] Wibmer, in *Die Wirkung*, &c.

The long and habitual use of ether diminishes the effect of this substance over the system, and, therefore, the dose must be proportionately increased. Dr. Christison mentions the case of an old gentleman who consumed sixteen ounces every eight or ten days, and had been in the habit of doing so for many years. Yet, with the exception of an asthma for which he took the ether, he enjoyed tolerable health. The chemist, Bucquet, who died of scirrhus of the colon, with inflammation of the stomach and of the intestines generally, took, before his death, a pint of ether daily, to alleviate his excruciating pains [v].

When the vapour of ether, sufficiently diluted with atmospheric air, is *inhaled*, it causes irritation about the epiglottis, a sensation of fulness in the head, and effects analogous to those caused by the protoxide of nitrogen (*vide* p. 156); moreover, persons peculiarly susceptible of the action of the one are also powerfully affected by the other [w]. If the air be too strongly impregnated with ether, stupefaction ensues. In one case this state continued with occasional periods of intermission for more than thirty hours: for many days the pulse was so much lowered that considerable fears were entertained for the safety of the patient (*op. cit.*) In another case, an apoplectic condition, which continued for some hours, was produced.

MODUS OPERANDI.—When ether is swallowed, it is rapidly absorbed, and subsequently thrown out of the system by the pulmonary surface. Magendie [x] says, that ether introduced into the cavity of the peritoneum is discoverable in the expired air by its odour. Thrown into the cavity of the pleura, it produces speedy death, and its odour is very obvious when we approach the mouth of the animal [y]. In the case of a man poisoned by laudanum, and to whom before death half an ounce of spirit of sulphuric ether was given, the ether was detected by its odour in the brain [z].

USES.—Ether is employed both medicinally and for pharmaceutical purposes.

1. *MEDICINAL USES.* *a. Internal.*—Ether is principally valuable as a speedy and powerful agent in spasmodic and painful affections, not dependent on local vascular excitement, and which are accompanied by a pale, cold skin, and a small, feeble palse. If adminis-

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[u] Schwilgué, *Traité de Mat. Méd.* 1818: also, Trousseau and Pidoux, *Traité de Thérap.* 1836.
[v] Mérat and De Lens, *Dict. Mat. Méd.*
[w] *Journal of Science*, vol. iv. p. 158.
[x] *Elem. Compend. Physiol.* by Milligan.
[y] *Lectures on the Tissues*, Lancet, Nov. 22, 1834.
[z] *Lancet* for 1836-7, vol. i. p. 271.

tered during a paroxysm of spasmodic asthma, it generally gives relief, but has no tendency to prevent the recurrence of attacks. In cramp of the stomach, singultus, and flatulent colic, its happy effects are well established[a]. It is sometimes highly advantageous in a paroxysm of angina pectoris. During the passage of urinary or biliary calculi, it may be used as a substitute for, or in combination with, opium, to overcome the spasm of the ducts or tubes through which the calculus is passing.

In the latter stages of continued fever, ether is sometimes admissible. It is employed to relieve the subsultus tendinum and hiccup. Desbois de Rochefort[b] administered it in intermittent fevers. He gave it about half an hour before the expected paroxysm; it acted as a mild diaphoretic, and prevented the recurrence of the attack.

Headache of the kind popularly called nervous, that is, unconnected with vascular excitement, is sometimes speedily relieved by ether. I have found it beneficial principally in females of delicate habits. In such it occasionally gives immediate relief, even when the throbbing of the temporal vessels and suffusion of the eyes (symptoms which usually contra-indicate the employment of ether), would seem to shew the existence of excitement of the cerebral vessels.

In flatulence of stomach it may be taken in combination with some aromatic water. Against sea-sickness it should be swallowed in a glass of white wine. Durande[c] recommends a mixture of three parts ether and two oil of turpentine, as a solvent for biliary calculi. Bourdier[d] employed ether to expel tape-worm. He administered it by the stomach and rectum, in an infusion of male fern, giving a dose of castor oil an hour after. In faintness and lowness of spirits, it is a popular remedy. In poisoning by hemlock and mushrooms, it has been employed[e]. In asphyxia it has been used with benefit.

The vapour of ether is inhaled in spasmodic asthma, chronic catarrh, and dyspnœa, hooping cough, and to relieve the effects caused by the accidental inhalation of chlorine gas. It may be used by dropping some ether in hot water, and inspiring the vapour mixed with steam, or it may be dropped on sugar, which is to be held in the mouth. The inhalation of the vapour of the ethereal tincture of hemlock is occasionally useful in relieving spasmodic affections of the respiratory organs, and has been recommended in phthisical cases.

β. *External.*—The principal external use of ether is to produce cold by its speedy evaporation. Thus, in strangulated hernia it may be dropped on the tumour and allowed to evaporate freely: by this means a considerable degree of cold is produced, and, in consequence, the bulk of the part diminished, whereby the reduction of the hernia is facilitated. Dropped on the forehead, or applied by means of a piece of thin muslin, ether diminishes vascular excitement, by the cold produced from its evaporation, and is exceedingly efficacious in headache and inflammatory conditions of the brain. In burns and scalds it may also be employed as a refrigerant. If its evaporation be stopped or checked, as by covering it with a compress, it acts as a local irritant, causing rubefaction, and, by long-continued application, vesication. It is used with friction as a local stimulant.

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[a] On the Effects of Ether in Spasmodic Affections of the Stomach, and in Intermittents. See *Medical Facts and Observations*, vol. v. Lond.

[b] *Cours Elém. de Matière Médicale.* Paris, 1789.

[c] *Observ. sur l'Efficacité du Mélange d'Ether sulphuriq. et d'Huile volatile du Téréb. dans Coliques hépatiq. produites par des Pierres Biliaires.* Strasburg, 1790.

[d] *Mém. de la Société de Méd.*

[e] J. Frank, *Toxicologie*, s. 70, 108.

2. Pharmaceutical Uses.—Ether is employed in the preparation of the Compound Spirit of Sulphuric Ether. Ether, or its alcoholic solution, is also used to extract the active principles of certain drugs, as of Lobelia, Aloes, Musk, &c. The solutions are called Ethereal Tinctures (*Tincturæ Ethereæ*), or by the French pharmacologists *Ethéroles*. These may be conveniently prepared by percolation (see p. 366). Ether is of assistance in determining the purity of some medicinal substances, as of Aconitina and Veratria, which are very soluble in it. It is also employed in toxicological researches, to remove Bichloride of Mercury from organic mixtures.

Administration.—It may be given in doses of from fʒss. to fʒij.:—a tea-spoonful is the ordinary quantity. This dose may be repeated at short intervals. It is usually exhibited in some aromatic water, and frequently in combination with other antispasmodics and stimulants, as ammonia, valerian, &c. "It may be perfectly incorporated with water, or any aqueous mixture, by rubbing it up with spermaceti employed in the proportion of two grains for each fluidrachm of the ether[f]."

Antidotes.—In cases of poisoning by ether, the same treatment is to be adopted as before recommended in cases of poisoning by alcohol.

1. SPIRITUS ÆTHERIS SULPHURICI, E. *Spirit of Sulphuric Ether.* (Sulphuric Ether, Oj.; Rectified Spirit, Oij. Mix them. The density of this preparation ought to be 0·809. "It does not affect litmus paper, or render water muddy: when agitated with twice its volume of a concentrated solution of muriate of lime, 28 per cent. of ether separates by rest.")—Its medicinal properties are similar to, though somewhat less powerful than, those of ether, over which it has the advantage of being miscible with water in all proportions. The dose of it is fʒj. to fʒiij. mixed with some diluent. It is used in the preparation of the *Tinctura Lobeliæ ætherea*, E.

2. SPIRITUS ÆTHERIS SULPHURICI COMPOSITUS, L. *Compound Spirit of Sulphuric Ether.* (Sulphuric Ether, f℥viij.; Rectified Spirit, f℥xvj.; Etherial Oil, fʒiij. Mix).—This preparation is commonly called *Hoffman's Mineral Anodyne Liquor* (*Liquor anodynus mineralis Hoffmanni*); being made in imitation of a preparation described by Hoffmann[g], and which it is said he was taught by an apothecary of the name of Martmeier[h]. This preparation is sometimes employed as an adjunct to laudanum, to prevent the nausea which the latter excites in certain habits. Its dose is from f ʒss. to f ʒij. in any proper vehicle.

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[f] *United States' Dispensatory*, p. 727, 3d edit. Philadelphia, 1836.

[g] *De Acido Vitrioli Vinoso*, 1732.—Fr. Hoffmanni, *Operum omnium Supplementum*, p. 855. Genevæ, 1754.

[h] Voigtells, *Vollstandiges System der Arzneymittellehre*, Bd. ii. 3^{tte} Abt. S. 38. Leipzig, 1817.

3. O'LEUM ÆTHE'REUM, *L.*—ETHEREAL OIL.

(Liquor Æthereus Oleosus, *D.*)

History and Synonymes.—This liquid is commonly termed *heavy oil of wine*, or simply *oil of wine*. Dumas[i] says it was known to Paracelsus, who designated it *sweet oil of vitriol*. Modern writers have given it various appellations founded on its supposed composition. Thus according to Mr. Hennell[j] it is a *sulphate of hydrocarbon*,—Dumas[k] calls it *sulphatic ether*,—others a *double sulphate of ether* and *hydrocarbon*,—while Liebig[l] terms it *sulphate of oxide of ethule and etherole*[m].

Preparation.—The following directions for procuring it are given in the *London Pharmacopœia* :—

> "Take of Rectified Spirit, lb. ij.; Sulphuric Acid, lb. iv.; Solution of Potash, Distilled Water, of each f ℥j.; or as much as may be sufficient. Mix the acid cautiously with the spirit. Let the liquor distil until a black froth arises; then immediately remove the retort from the fire. Separate the lighter supernatant liquor from the heavier one, and expose the former to the air for a day. Add to it the solution of potash first mixed with water, and shake them together. Lastly, when sufficiently washed, separate the ethereal oil which subsides."
>
> The *Dublin College* gives the following directions for its preparation :—Take what remains in the retort after the distillation of sulphuric ether. Distil down to one half, with a moderate heat."

The process of the London Pharmacopœia is that followed at Apothecaries' Hall, London. Mr. Hennell informs me that 33lbs. avoird. of Rectified Spirit, and 64lbs. avoird. of Oil of Vitriol, yielded in one operation 17 ounces avoird. of ethereal oil. There is, therefore, an immense loss in the operation.

Theory of the Process.—When oil of vitriol and alcohol are mixed, bisulphate of oxide of ethule ($C^4\ H^5\ O,\ 2SO^3$) and water are formed (see p. 370). Under the influence of heat the bisulphate suffers decomposition; but the reactions vary with the temperature. When the sulphuric acid is greatly in excess, and the boiling point of the liquid has attained 320° F., the principal products of the decomposition are sulphurous acid, olefiant gas (carbo-hydrogen), water, and carbon (see p. 371). At this period of the process heavy oil of wine is also produced in small quantity. Its formation may be accounted for by supposing that two equivalents of the bisulphate of oxide of ethule and water react on one another, and that the carbo-hydrogen ($C^4\ H^4 = 1$ eq. Etherole) of the one is substituted for the water of the other; the products being heavy oil of wine (*oleum æthereum*, Ph. L.) sulphuric acid, and water.

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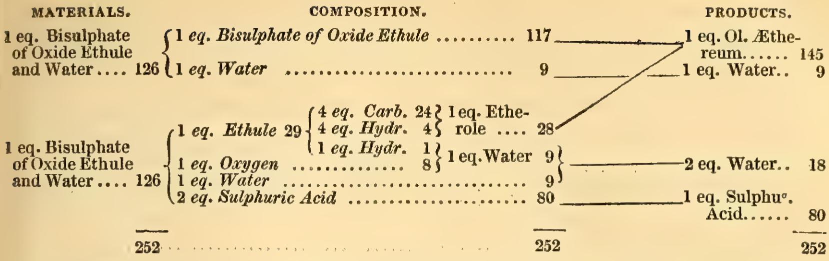
[i] *Traité de Chimie*, t. 5^{me}, p. 543.

[j] *Philosophical Transactions*, 1826.

[k] *Op. supra cit.*

[l] Turner's *Elements of Chemistry*, p. 844 and 861, 7th ed. 1841.

[m] The term *etherole* is applied to a $\frac{4}{4}$ carbo-hydrogen, better known as *Light Oil of Wine.*


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Bisulphate of Oxide Ethule and Water.... 126
1 eq. Bisulphate of Oxide Ethule 117
1 eq. Water 9
1 eq. Ol. Æthereum...... 145
1 eq. Water.. 9
1 eq. Bisulphate of Oxide Ethule and Water.... 126
1 eq. Ethule 29
4 eq. Carb. 24
4 eq. Hydr. 4
1 eq. Etherole 28
1 eq. Hydr. 1
1 eq. Oxygen 8
1 eq. Water 9
1 eq. Water 9
2 eq. Water.. 18
2 eq. Sulphuric Acid 80
1 eq. Sulphuc. Acid...... 80
252
252
252

The substance termed by Liebig, Etherole ($C^4 H^4$) is commonly denominated *Light Oil of Wine.* It was discovered by Hennell, who calls it *Hydrocarbon from Oil of Wine*, because it is obtained by boiling the heavy oil of wine with water. It is a colourless, oily liquid, of sp. gr. 0·917 to 0·920. When kept for some time at a low temperature it deposits a crystalline matter called Etherine or *Camphor of Oil of Wine* ($C^4 H^4$); which is isomeric with etherole.

Properties. — Ethereal oil is an oily liquid, usually having a yellowish tint, though when quite pure it is said to be colourless. It has a peculiar aromatic odour, and a bitter taste. Its sp. gr., according to Mr. Hennell, is 1·05; but according to Serullas it is 1·13. It boils at 540° F. It is insoluble in water, but dissolves readily in alcohol and ether. It neither reddens litmus nor precipitates a solution of chloride of barium, so that the sulphuric acid contained in it seems to be completely neutralized. According to Mr. Hennell ethereal oil dissolves a variable quantity of a $\frac{4}{4}$ carbo-hydrogen, part of which separates in a crystalline form (*etherine*) when the oil is kept for some time, or when exposed to cold.

When ethereal oil is slightly heated with water it yields a light yellow oil (*etherole*), which floats on water, and bisulphate of oxide of ethule, which is dissolved by the water.

Characteristics.—Ethereal oil is recognised by its oily appearance, its peculiar odour and taste, its slight solubility in, but greater specific gravity than, water, and its solubility in ether and alcohol. If it be heated in a test tube it yields an inflammable vapour which burns like olefiant gas, and a carbonaceous residue which contains sulphuric acid, as is proved by lixiviating with water, and testing by chloride of barium. Ethereal oil, added to a solution of chloride of barium, occasions no cloudiness; but, if we evaporate the mixture to dryness, the residue is found to contain sulphate of baryta.

Composition.—Three chemists have analysed ethereal oil, namely, Hennell, Serullas, and Liebig. The results of two only of these agree, namely, those of Liebig and Serullas.

	LIEBIG AND SERULLAS.					HENNELL.		
	Atoms.	*Eq.Wt.*	*Theory.*	*Liebig.*	*Serullas.*	*Eq.*	*Eq.Wt.*	*Per Cent.*
Sulphuric Acid	2	80	55·172	55·614	55·02	1	40	38·0
Carbon	8	48	33·103	33·180	33·05	9	54	53·7
Hydrogen	9	9	6·207	5·788	6·11	9	9	8·3
Oxygen	1	8	5·517	5·418	5·49	0	0	0·0
Oleum Æthereum (Ph. L.)	1	145	99·999	100·000	99·67	1	103	100·0

It would appear, from this table, that Hennell[n] must have analysed ethereal oil holding in solution carbohydrogen (*etherine*), and that he omitted to take into calculation the elements of water which this oil contains.

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[n] *Philosophical Transactions*, 1826, p. 247 and 248.

According to Serullas[o] and Liebig[p] this oil is a double sulphate of oxide of ethule (ether) and etherole (carbohydrogen).

	Atoms.	*Eq.Wt.*	*Or.*	*Atoms.*	*Eq.Wt.*
2 eq. Sulphuric Acid	2	80	Sulphate of Oxide of Ethule (Ether)	1	77
1 eq. Oxide of Ethule (Ether)	1	37	Sulphate of Etherole (Carbohydrogen)	1	68
1 eq. Etherole (Carbohydrogen)	1	28			
1 Sulphate of Oxide of Ethule and Etherole	1	145		1	145

Dumas[q], however, regards it as true sulphatic ether (SO^3, $C^4 H^5 O$), holding in solution variable quantities of carbohydrogen.

Physiological Effects.—These have not been determined. I gave fifteen drops to a small rabbit: death took place within an hour. The symptoms were indisposition to move, apparent tendency to sleep, followed by incapability of supporting the erect position, occasional convulsive movements, grating of the teeth, and insensibility. The body was opened immediately after death: the heart was still beating, and its right cavities were gorged with purple blood. Ethereal oil, therefore, acts on the nervous system in a somewhat analogous way to ether.

Uses.—Ethereal oil is used in the manufacture of the *Spiritus Ætheris Sulphurici Compositus* of the Pharmacopœia (see p. 377).

"Dr. Hare," in his *Chemical Compendium*, "reports the opinion of Drs. Physick and Dewees in favour of the efficacy of the officinal oil of wine, dissolved in alcohol, in certain disturbed states of the system, as a tranquillizing and anodyne remedy[r]."

4. SPIR'ITUS Æ'THERIS NI'TRICI, *L. E.*—SPIRIT OF NITRIC ETHER, OR SWEET SPIRIT OF NITRE.

(Spiritus Æthereus Nitrosus, *D.*—Hyponitrous Ether, with four volumes of Rectified Spirit, *E.*)

History.—The first traces of this preparation are to be found in the writings of Raymond Lully, in the 13th century[s]. Basil Valentine, in the 15th century, taught a much improved method of preparing it[t]. Nitric ether was first mentioned by Kunkel, in 1681[u].

Spirit of nitric ether has been known by various names, such as *Dulcified Acid of Nitre* (*Acidum Nitri dulcificatum*), *Sweet Spirit of Nitre* (*Spiritus Nitri dulcis*), *Spirit of Nitrous Ether* (*Spiritus Ætheris Nitrosi*), and *Nitre Drops*.

Preparation.—It is usually prepared by the action of nitric acid on rectified spirit at one operation, as in the process of the *London College*, which is that employed at Apothecaries' Hall, London. Or it may be procured by first preparing nitric [hyponitrous] ether, and subsequently diluting this with rectified spirit, as in the process of the *Edinburgh College*.

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[o] *Ann. de Chim. et de Phys.* t. xxxix. p. 153.
[p] Turner's *Elements of Chemistry*, 7th ed. pp. 844 and 861.
[q] *Traité de Chimie appliqué aux Arts*, t. v. p. 545. Paris, 1835.
[r] *United States' Dispensatory.*
[s] Dulk, *Die Preussische Pharmakopöe übers. und erläutert*, 2er Th. S. 704, 2te Aufl. Leipzig, 1830.
[t] Ibid.
[u] Thomson, *System of Chemistry of Inorganic Bodies*, vol. ii. p. 317, 7th edit. 1831.

1. Preparation of Hyponitrous Ether.—Liebig[v] has lately given the following method of obtaining this compound in a state of purity:—"One part of starch, and ten parts of nitric acid, sp. gr. 1·3, are introduced into a capacious retort, which is connected by means of a wide tube, bent at right angles, with a two-necked bottle, so that the further end of the tube reaches to the bottom of the bottle. Into this bottle is introduced a mixture of two parts of alcohol at 85 p. c. and one part of water, and it is surrounded by cold water. The second aperture of the bottle is connected, by means of a long wide tube, with a good cooling apparatus or condenser. The starch and nitric acid are heated in the water-bath; pure hyponitrous acid is disengaged, which, passing through the alcohol, instantly combines with the ether, forming hyponitrite of oxide of ethule, which distils in a continuous stream. This process is very productive. By means of water, the new ether is purified from alcohol, and by standing over chloride of calcium it is freed from water. The tube which connects the retort with the two-necked bottle must have a length of two or three feet, and must be surrounded with moist paper during the operation. If the alcohol be not carefully cooled, it becomes spontaneously hot, and boils violently. From this moment the hyponitrite of ethule is no longer pure."

The process of the *Edinburgh College* for the preparation of hyponitrous ether is as follows:—Take of Rectified Spirit, Oij. and f℥vj.; Pure Nitric Acid (Density 1·500) f℥vij. Put fifteen fluidounces of the spirit, with a little clean sand, into a two-pint matrass, fitted with a cork, through which are passed a safety tube, terminating an inch above the spirit, and another tube leading to a refrigeratory. The safety-tube being filled with pure nitric acid, add through it gradually three fluidounces and a half of the acid. When the ebullition which slowly arises is nearly over, add the rest of the acid gradually, half a fluidounce at a time, waiting till the ebullition caused by each portion is nearly over before adding more, and cooling the refrigeratory with a stream of water, iced in the summer. The ether thus distilled over being received in a bottle, is to be agitated first with a little milk of lime, till it ceases to redden litmus paper, and then with half its volume of concentrated solution of muriate of lime. The pure hyponitrous ether thus obtained should have a density of 0·899.

The process of the *Dublin College* is as follows:—Take of Nitrate of Potash, purified, dried, and coarsely powdered, lb. iss.; Sulphuric Acid, lb. j.; Rectified Spirit, f℥xix. Put the nitrate of potash into a tubulated retort placed in a bath of cold water, and pour on it by degrees and at intervals, the sulphuric acid and the spirit, previously mixed and cooled after their mixture. Without almost any external heat, or at most a very gentle one (as of warm water added to the bath), the ethereal liquor will begin to distil without the application of fire; in a short time the heat in the retort will increase spontaneously, and a considerable ebullition will take place, which must be moderated by reducing the temperature of the bath with cold water. The receiver must also be kept cold with water or snow, and furnished with a proper apparatus for transmitting the highly elastic vapour (bursting from the mixture with great violence if the heat be too much increased) through a pound of rectified spirit contained in a cool phial. The ethereal liquor thus spontaneously distilled, is to be received into a phial with a ground-glass stopper, and there must be added by degrees (closing the phial after each addition) as much very dry and powdered carbonate of potash as will suffice to saturate the excess of acid, using litmus as a test: this is effected by the addition of about a drachm of the salt. In a short time the nitrous ether will rise to the surface, and is to be separated by means of a funnel.

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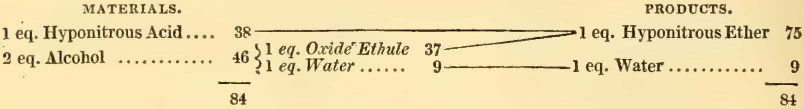
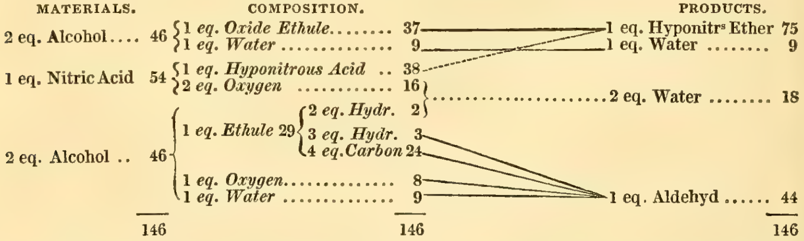
[v] Turner's *Elements of Chemistry*, 7th edit. p. 848.

If the ether be required very pure, distil it again to one half, from a water-bath at a temperature of 140°. Its specific gravity is, to that of distilled water, as 0·900 to 1·000.

The *theory* of Liebig's process for making hyponitrous ether is simple. Starch deoxidizes nitric acid and evolves hyponitrous acid [the nitrous acid of Graham and continental chemists]. This being conveyed into alcohol, combines with the oxide of ethule of the latter, and disengages the water.


MATERIALS.
PRODUCTS.
1 eq. Hyponitrous Acid.... 38
2 eq. Alcohol 46
1 eq. Oxide Ethule 37
1 eq. Water 9
1 eq. Hyponitrous Ether 75
1 eq. Water 9
84
84

Hyponitrous ether is, however, usually prepared by the action of nitric acid on alcohol; as in the Edinburgh and Dublin processes. The reactions are then more complicated, but vary with the strength of the acid and the temperature. They essentially depend on the deoxidation of the nitric acid by the hydrogen and carbon of the ethule of part of the alcohol. As hydrogen has more affinity than carbon for oxygen, it follows that in the earlier stages, and when reaction is moderate, it is the hydrogen of the ethule which is oxidized by the oxygen of the nitric acid. Thus, when we employ a dilute acid, or moderate the reaction by cold, the products are aldehyd (hydrated oxide of acetule [w]), water, and hyponitrous ether.



When, however, the reaction is more energetic, as when strong nitric acid is employed, and the temperature is not moderated, the carbon as well as the hydrogen of the ethule is oxidised by the oxygen of the acid, and several products, besides those above mentioned, are then obtained. Carbonic ($C\,O^2$) and oxalic ($C^2\,O^3$) acids are formed by the oxidation of the carbon. Acetic ($C^4\,H^3\,O^3$) and formic ($C^2\,H\,O^2$) acids are also generated; "besides acetate and formiate of ethule" (Liebig). By the deoxidation of nitric acid there are obtained, besides hyponitrous acid already mentioned, nitrous acid, binoxide of nitrogen, protoxide of nitrogen and nitrogen (Thenard).

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[w] *Acetule*, and the *oxide of acetule*, are hypothetical substances. Aldehyd is regarded as the hydrate of the hypothetical oxide of acetule.

2. Preparation of Spiritus Ætheris Nitrici.—The processes of all the British Colleges differ from each other.

The *London College* orders of Rectified Spirit, lbiij.; Nitric Acid, ℥iv. Add the Acid gradually to the Spirit, and mix; then let 32 fluidounces distil.

The *Edinburgh College* directs the pure hyponitrous ether (obtained by the process above detailed) to be mixed with the remainder (*i. e.* f℥xxxj.) of the rectified spirit, or exactly four times its volume. Spirit of nitric ether ought not to be kept long, as it always undergoes decomposition, and becomes at length strongly acid. Its density, by this process, is 0·847.

The directions of the *Dublin College* are as follows:—Add to the matter which remains after the distillation of nitrous ether, the rectified spirit employed in that operation for condensing the elastic vapour, and distil till the residuum be dry, with the greater heat of a warm bath. Mix the distilled liquor with the alkaline liquor which remains after the separation of the nitrous ether, and add, moreover, as much well-dried carbonate of potash as shall be sufficient to saturate the predominant acid. This is made evident by the test of litmus. Lastly, distil as long as any drops come over by the medium heat of a warm bath. The sp. gr. of this liquor is to that of distilled water as 0·850 to 1000. Nitrous ethereal spirit may also be prepared by adding two ounces of nitric acid to a pound, *by measure*, of rectified spirit, and distilling twelve ounces with a proper apparatus and the application of a gentle heat.

At Apothecaries' Hall, London, this preparation is made in an earthenware still, with a condensing worm of the same material. The still is heated by the slow application of steam to its outer surface[x].

The *theory*[y] of the process is essentially the same as that for preparing pure hyponitrous ether. The latter, when formed, distils over along with rectified spirit, and constitutes the spiritus ætheris nitrici, *Ph. L.*

PROPERTIES. *a. OF HYPONITROUS ETHER.—Pure hyponitrous ether*, prepared by Liebig's process, is pale yellow, has a most fragrant smell of apples and Hungary wines, boils at 62°, and has the sp. gr. of 0·947 at 60°. It may be mixed with an alcoholic solution of potash without becoming brown (showing the absence of aldehyd): hyponitrite of potash and alcohol are formed. *Impure hyponitrous ether*, prepared by the ordinary processes, boils at 70° F., and has the sp. gr. 0·886 at 40°. Its smell is like that of the former, but at the same time suffocating. Mixed with an alcoholic solution of potash it becomes dark brown (showing the presence of aldehyd), with the production of resin of aldehyd. It is highly inflammable, burning with a bright flame. When kept it becomes acid, while nitric oxide gas is given off. This tendency to become acid is greater when air is admitted, and depends on the presence of aldehyd, which is oxidised by the oxygen of the air, or of the hyponitrous acid. It is soluble in 48 parts of water, and miscible, in all proportions, with ether and alcohol (Liebig) The following is the composition of the pure hyponitrous ether:—

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[x] Brande, *Manual of Pharmacy*, p. 461, 3rd edit. Lond.

[y] Dr. Golding Bird (*Lond. and Edinb. Phil. Mag.* 1839, vol. xiv. p. 324) says, that while the ether distils, mixed with alcohol only, oxalhydric [saccharic] acid ($C^{12} H^{10} O^{16}$), but no oxalic acid is formed. He also states, that aldehyd is generated, but does not appear in the distilled liquid until the formation of ether has nearly or entirely ceased; the aldehyd and oxalic acid being nearly of simultaneous origin.

	Atoms.	Eq.Wt.	Theory.	Dumas & Boullay.
Carbon	4	24	32·00	32·69
Hydrogen	5	5	6·67	6·85
Oxygen	4	32	42·67	41·46
Nitrogen	1	14	18·66	19·00
Hyponitrous Ether	1	75	100·00	100·00

Or,	Atoms.	Eq.Wt.	Per Cent.
Hyponitrous Acid	1	38	50·66
Oxide of Ethule (Ether).	1	37	49·34
Hyponitrite of Oxide of Ethule	1	75	100·00

β. *Of Spiritus Ætheris Nitrici.*—Spirit of nitric ether is a colourless, limpid liquor, having a fragrant ethereal odour, somewhat analogous to that of ripe apples, and a pungent, aromatic, sweetish acidulous taste. Prepared according to the London Pharmacopœia its sp. gr. should not exceed 0·834; but the preparation of the Edinburgh Pharmacopœia has a sp. gr. of 0·847. It is very volatile, producing much cold by its evaporation. It is very inflammable, and burns with a whitish flame. By keeping it usually becomes strongly acid; though I have had some kept for several years which possessed only slight acidity. It dissolves in alcohol and water in all proportions. "Hyponitrous ether may be separated from the alcohol, water, and uncombined acid, which the preparation of the pharmacopœia contains, by digesting lime reduced to powder in it, and subjecting the mixture to distillation[z].

Characteristics.—It is principally distinguished by its peculiar odour, its inflammability, its lightness, and its miscibility with water. The spirit of nitric ether of the shops usually strikes a deep olive colour with the protosulphate of iron, thereby indicating the presence of binoxide or an acid of nitrogen; and produces, with tincture of guaiacum, a blue tint, which passes through various shades of green: this last effect depends on the presence of an acid of nitrogen. These effects are not invariably produced; for in some spirit of nitric ether which I have had for several years they do not take place.

COMPOSITION.—Spirit of nitric ether is a mixture of [impure] *hyponitrous ether* and *rectified spirit.* Prepared according to the Edinburgh Pharmacopœia, its composition is as follows:—

	Vols.	Sp. gr.	Weight.
Hyponitrous Ether	1	0·886	20·9
Rectified Spirit	4	0·838	79·1
Spiritus Ætheris Nitrici, *Ph. Ed.*	5	0·847	100·0

PURITY.—Few articles of the pharmacopœia are more extensively adulterated than spirit of nitric ether. To prove how great a fraud must be practised with it, I may mention that, in July, 1840, Mr. Hennell informed me, that it was then selling in the trade at a price which was but just above that of the duty on the spirit used in manufacturing the genuine article. Wholesale dealers usually keep two, or even three, qualities of this preparation: the inferior ones being obtained by diluting the best with different quantities of water, or spirit of wine and water. Some years since large quantities of spirit of wine, flavoured with hyponitrous ether, were imported from Ireland into London, under the name of spirit of nitric ether, in order to evade the duty payable on it as spirit of wine. Aldehyd and an acid of nitrogen are accidental impurities frequently present.

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[z] Mr. R. Phillips, *Translation of the Pharmacopœia,* 4th ed. Lond. 1841.

The goodness of Spirit of Nitric Ether is to be estimated in part by an attentive examination of the flavour, and by taking the specific gravity of this liquid. Prepared according to the process of the London Pharmacopœia, its density is 0·834. A free acid (an acid of nitrogen) may be recognised by litmus, and by the effervescence produced on the addition of the alkaline carbonates. The *Edinburgh College* gives the following characteristics of the purity of spirit of nitric ether:—

> "Density, 0·847: it effervesces feebly, or not at all, with a solution of bicarbonate of potash. When agitated with twice its volume of muriate of lime, 12 per cent. of ether slowly separates."

Two samples of spirit of nitric ether, prepared by Messrs. Howard and Co. of Stratford, I found to be 47·8 *over proof*, according to Sikes's hydrometer; indicating the sp. gr. to be about 0·85. But I failed to separate the hyponitrous ether by the use of a solution of muriate of lime, as directed by the Edinburgh College.

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—Its effects on plants have not been ascertained.

β. On Animals.—I am not acquainted with any experiments made to determine its effects on animals generally. Veterinarians employ it as a diuretic on various occasions, and as a stimulant in the advanced stages of fever to rouse the exhausted powers of horses[a].

γ. On Man.—The inhalation of its vapour is dangerous when too long continued, as is proved by the following case. A druggist's maid-servant was found one morning dead in her bed, and death had evidently arisen from the air of her apartment having been accidentally loaded with the vapour of this liquid from the breaking of a three-gallon jar of it. She was found lying on her side, with her arms folded across the chest, the countenance and posture composed, and the whole appearance like a person in a deep sleep[b]. Taken internally in moderate doses it operates as a volatile stimulant and diuretic. According to the experiments of Alexander[c] it acts mildly on the kidneys. It is believed to possess diaphoretic properties. By some pharmacologists it is described as being refrigerant,—a quality which it owes perhaps to the free acid which it usually contains. I am unacquainted with the effects of large doses, but they are probably analogous to, though less energetic than, those of other ethereal compounds. Kraus[d] says, a boy twelve years of age took a drachm in the morning fasting, and that it caused violent colic which lasted for six hours, and was accompanied with vomiting.

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[a] Youatt, *The Horse*, in the Library of Useful Knowledge.

[b] Christison's *Treatise on Poisons.*

[c] See p. 199.

[d] *Heilmittellehre*, S. 484. Göttingen, 1831.

Probably these effects arose from the preparation containing a considerable quantity of free acid.

Uses.—It is employed as a diuretic in some disorders of children and in mild dropsical complaints, as in the anasarca which follows scarlatina. It is given in conjunction with squills, acetate or nitrate of potash, or foxglove. As a refrigerant and diaphoretic, it is used in febrile complaints in combination with the acetate of ammonia and emetic tartar. As a carminative it is frequently useful in relieving flatulence and allaying nausea. On account of its volatility it may be applied to produce cold by its evaporation. Spirit dealers employ it as a flavouring ingredient.

Administration.—The usual dose of this liquid in febrile cases is fʒss. to fʒij or fʒiij. When we wish it to act as a diuretic, it should be given in large doses, as two or three tea-spoonfuls.

Antidotes.—In poisoning by the inhalation of the vapour of this compound, the treatment will be the same as that described for poisoning by carbonic acid gas.

5. Æ'THER HYDROCHLO'RICUS.—HYDROCHLORIC ETHER.

History and Synonymes.—In the Edinburgh Pharmacopœia for 1735, was a preparation called *Spiritus Salis dulcis.* It was a solution of Hydrochloric Ether in rectified spirit. Very little, however, was known of the properties of this ether till Gehlen published a dissertation on the subject, in 1804 [e]. This ether has had various appellations, such as *Chlorhydric Ether*, *Muriatic Ether*, *Marine Ether*, and, hypothetically, *Chloride of Ethule.*

Preparation.—It is best obtained by saturating alcohol with hydrochloric acid gas (see p. 274), and distilling, by means of a water-bath, into a carefully cooled receiver.

By the reaction of one equivalent or 37 parts of hydrochloric acid (Chl. H) on two equivalents or 46 parts of alcohol ($C^4 H^5 O + HO$), we obtain one equivalent or 65 parts of hydrochloric ether ($C^4 H^5 Chl.$) and two equivalents or 18 parts of water ($2 HO$).

Properties.—Hydrochloric ether is a colourless liquid, having a penetrating odour, and a taste somewhat sweetish. Its sp. gr. is 0·874 at 40° F. It boils at 51° F. This great volatility prevents its being kept in the shops. When pure it is quite neutral, dissolves in about 24 parts of water, does not precipitate nitrate of silver, and burns with a flame edged with green, producing vapours of hydrochloric acid. By the slow action of hydrate of potash on it, chloride of potassium and alcohol are formed.

Its composition is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*
Carbon	4	24	36·92
Hydrogen	5	5	7·69
Chlorine	1	36	55·38
Hydrochloric Ether	1	65	99·99

Or,	*Atoms.*	*Eq.Wt.*	*Per Cent.*
Ethule	1	29	44·61
Chlorine	1	36	55·38
Chloride Ethule	1	65	99·99

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[e] Thomson's *System of Chemistry of Inorganic Bodies*, vol. ii. p. 310, 7th ed. Lond. 1831.

Physiological Effects and Uses.—It is a highly diffusible stimulant, like the other ethers, but is rarely employed alone; though it has been used as an antispasmodic.

SPIRITUS ÆTHERIS HYDROCHLORICI; *Æther Muriaticus Alcoholicus; Spiritus Muriatico-Æthereus; Spiritus Salis dulcis; Spirit of Hydrochloric Ether; Spirit of Muriatic Ether; Dulcified Marine Acid.*—In the Edinburgh Pharmacopœia for 1735, this was ordered to be prepared by adding one part of muriatic acid to three parts of rectified spirit, digesting for some days, and then distilling by a sand heat. Or it may be prepared by dissolving hydrochloric ether in an equal volume of rectified spirit. Liebig says, that the spiritus muriatico-ethereus, used on the continent, contains *heavy muriatic ether*, the composition of which is not known. The action of spirit of muriatic ether seems to be similar to that of spirit of nitric ether. A scruple of it thrown into the veins of a buck augmented the renal secretion[f]. An ounce and a half injected into the jugular vein of a dog, coagulated the blood, caused difficulty of breathing, and death[g]. It has been used in dyspeptic affections, connected with hepatic obstructions. In hectic fever, Berends[h] found its continued use beneficial. The dose of it is fʒi. to fʒiij.

6. ÆTHER ACE'TICUS.—ACETIC ETHER.

History.—It was discovered by Count de Lauraguais, in 1759[i].

Preparation.—It is prepared by submitting to distillation a mixture of 16 parts of dry acetate of lead, 4½ of alcohol, and 6 of oil of vitriol; or 10 parts of crystallized acetate of soda, 15 of oil of vitriol, and 6 of alcohol, at 80 or 85 per cent. The product is rectified with slaked lime and chloride of calcium, to remove acid and water; and a quantity of acetic ether, equal in weight to the alcohol, is obtained. (Liebig.)

Properties.—Acetic ether is colourless, and has an agreeable odour of acetic acid and ether. Its sp. gr. is 0·89 at 60°. It boils at 165°. It is soluble in 7 parts of water, and mixes with alcohol and ether in every proportion. Oil of vitriol resolves it into ether and acetic acid.

Composition.—The composition of this ether is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Or,*	*Atoms.*	*Eq. Wt.*	*Per Cent.*
Carbon	8	48	54·54	Ethule	1	29	32·95
Hydrogen	8	8	9·1	Oxygen	1	8	9·1
Oxygen	4	32	36·36	Acetic Acid	1	51	57·95
Acetic Ether	1	88	100·00	Acetate of the Oxide of Ethule	1	88	100·00

Physiological Effects and Uses.—Acetic ether is not used in medicine in this country. On the continent, however, it is occasionally employed. It is somewhat similar in its operation to the other ethers; but is milder, more agreeable, and more diaphoretic.

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[f] Lanzoni, quoted by Wibmer, *Die Wirkung*, &c. Bd. i S. 56.

[g] Freind, quoted by Wibmer.

[h] Sundelin, *Handbuch der speciellen Heilmittellehre*, Bd. ii. S. 71. 3$^{\text{tte}}$ Aufl. Berlin, 1833.

[i] Thomson, *op. supra cit.*

It is used in nervous and putrid fevers, in cardialgia, spasmodic vomiting, and asthenic affections of the stomach and alimentary canal[j]. Dose, fʒss. to f℥ij.

7. AC′IDUM ACE′TICUM, *L. E. D.*—ACETIC ACID.

History.—Vinegar must have been known from the most remote periods of antiquity. It is mentioned, by Moses[k], 1490 years before Christ. Hippocrates[l] employed it (ὄξυς) medicinally. Hannibal, in his passage over the Alps, is said to have softened the rocks by fire and vinegar[m]. Geber[n] was acquainted with the purification of vinegar by distillation. Stahl, in 1723, obtained concentrated acetic acid from the acetates by the action of sulphuric acid[o].

Natural History.—Acetic acid is peculiar to the organized kingdom.

Acetic acid, free, or combined with potash, lime, or ammonia, is met with in the juices of many plants. Thus, Vauquelin found the acetates of potash and lime in the sap of the Elm; and Morin detected acetate of ammonia in the fruit of Areca Catechu. Many vegetable substances yield it by decomposition.

Acetic acid is said to have been detected in the gastric juice, the perspiration, the urine, the milk, and the blood. It is probable, however, that in most, if not all, of these cases, lactic acid was mistaken for acetic acid.

Gmelin[p] says, acetic acid has been found in some mineral waters. If the observation be correct, the acid is probably to be referred to some decomposing organic matter accidentally present in the water. Geiger[q] states, that acetate of potash is found in some mineral waters.

Preparation—The acetic acid of commerce is obtained from two sources—vinegar and pyroligneous acid: the first is procured by exciting the acetous fermentation in certain liquors, the other by the distillation of wood.

1. Acetous Fermentation.—All liquids which are susceptible of vinous fermentation may be made to yield vinegar. A solution of saccharine matter (or some substance capable of producing sugar) is the essential ingredient. It is converted, by fermentation, first into alcohol, and subsequently into acetic acid.

The liquids employed in the manufacture of vinegar vary according to circumstances. In this country the vinegar of commerce is obtained from an infusion of malt, or of a mixture of malt and raw barley. In wine countries it is procured from inferior wines. Dilute spirit, beer, a solution of sugar, and other liquids, are also susceptible of the acetous fermentation.

1. *Malt Vinegar* (*Acetum*, L.; *Acetum Britannicum*, or *British Vinegar*, E.)— This is prepared from malt, or a mixture of malt

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[j] Sundelin, *op. supra cit.*

[k] *Numbers*, ch. vi. ver. 3.

[l] *De Natura Muliebri.*

[m] Livy, c. 37.—Polybius, however, from whom Livy has borrowed the greater part of his narrative, does not mention the use of vinegar. See some remarks on this subject in *A Dissertation on the Passage of Hannibal over the Alps*, p. 107. Oxford, 1820.

[n] *Investigation of Perfection*, ch. iii.

[o] Dulk, *Die Preussische Pharmakopöe übers. und erläutert*, 2ter Th. S. 123, 2te Aufl. Leipz. 1830.

[p] *Handb. d. Chem.* Bd. ii. S. 126.

[q] *Handb. d. Pharm.* Bd. i. S. 601, 3te Aufl.

and raw barley, which is mashed with hot water, as in the ordinary operation of brewing. The cooled wort is then transferred to the fermenting tun, where it is mixed with yeast, and undergoes the vinous fermentation. The wash is then introduced into barrels standing endways, tied over with a coarse cloth, and placed close together in darkened chambers, artificially heated by a stove[r]. Here the liquor remains until the acetous fermentation is complete. This process usually occupies several weeks, or even months. The product is not yet fit for sale. It is introduced into large tuns furnished with false bottoms, on which is placed *rape* (the residuary fruit which has served for making domestic wines). These rape-tuns are worked by pairs; one of them is quite filled with the vinegar from the barrels, and the other only three-quarters full, so that the fermentation is excited more easily in the latter than the former, and every day a portion of the vinegar is conveyed from one to the other, till the whole is completely finished, and fit for sale[s]. Green twigs, or fresh cuttings of the vine, recommended by Boerhaave, are sometimes employed, instead of rape, to flavour vinegar.

Formerly acetification was effected by placing the wash in barrels, the bung-holes of which were loosely covered with tiles. These barrels were then exposed to the sun and air for several months, until the acetification was perfect. But the introduction of stoved chambers has nearly superseded this method.

Malt vinegar has a yellowish red colour, an agreeable acid taste, which it owes to acetic and partly to sulphuric acid, and a peculiar, refreshing, pleasant odour, which it derives from acetic acid and acetic ether. Vinegar of four different degrees of strength are sold by the makers, and are distinguished as Nos. 18, 20, 22, and 24: the latter, which is the strongest, is also called *proof vinegar*, and is estimated to contain 5 per cent. of real acetic acid; but, according to Mr. Phillips, it does not usually contain more than 4·6 per cent. One fluidounce (= 446 grs.) of the latter strength should saturate very nearly 58 grs. of crystallized carbonate of soda. In the London Pharmacopœia it is stated that one fluidounce should saturate 60 grs. of crystallized carbonate of soda: the two grains extra being "allowed for saturating the sulphuric acid permitted to be mixed with vinegar, and for decomposing the sulphates of the water used in vinegar-making[t]." The Edinburgh College fixes the density of British vinegar at from 1·006 to 1·012; but it is usually higher than this. Mr. Phillips[u] found it, in one sample obtained from a respectable source, to be 1·019. Dr. T. Thomson found it to vary from 1·0135 to 1·0251. Vinegar is very liable to undergo decomposition: it becomes turbid, loses its acidity, acquires an unpleasant odour, and deposits a slippery gelatiniform substance. The mucilaginous coat or skin which forms on the surface of vinegar, and is called the *mother of vinegar*, appears to consist of myriads of exceedingly minute vegetables, having a globular form[v]. The surface of vinegar is frequently covered by Mouldiness (*Mucor Mucedo*). The microscopic animals, called Vinegar Eels[w] (*Anguillula Aceti*), are generated and nourished in vinegar. They may be destroyed by submitting the liquid in which they are contained to heat. Vinegar is also infested by a small fly (*Musca cellaris*).

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[r] The proper temperature is usually stated to be about 80° F.; but I suspect a much higher temperature is employed. I found the heat of one of these chambers so great that I was unable to support it beyond a few minutes. The proprietor of the establishment (one of the largest vinegar works in the metropolis) refused to allow me to inspect the thermometer hanging up in the chamber.

[s] For further information on this subject, consult Aikins' *Dictionary of Chemistry*, vol. ii. p. 468, Lond. 1807; and Donovan's *Domestic Economy*, vol. i. 1830, in Lardner's *Cabinet Cyclopædia*.

[t] Mr. R. Phillips, *Translation of the Pharmacopœia*, 4th ed. p. 51. Lond. 1841.

[u] *Lond. Medical Gazette*, N.S., vol. ii. for 1838-39, p. 687.

Malt vinegar consists of *water*, *acetic acid*, *acetic ether*, *colouring matter*, *a peculiar organic matter*, commonly denominated mucilage, a small portion of *alcohol* and *sulphuric acid*. Vinegar makers are allowed to add one-thousandth part by weight of sulphuric acid. This may be detected by a solution of chloride of barium, which forms a white precipitate (*sulphate of baryta*), insoluble in nitric acid. The quantity of sulphate of baryta thrown down from a fluidounce of vinegar, by the addition of solution of chloride of barium, should not exceed 1·14 grains[x], (*Ph. L*). If the vinegar be free from copper, lead, tin, and other metallic matter, it yields no precipitate on the addition of hydrosulphuric acid (sulphuretted hydrogen). The presence of hydrochloric acid may be recognised by nitrate of silver, which produces a white precipitate (*chloride of silver*) with it, insoluble in nitric acid. The presence of nitric acid in vinegar may be recognised by boiling this liquid with indigo, which is rendered yellow by nitric acid. Or it may be detected by saturating the suspected acid with potash or soda, and evaporating to dryness: the residue deflagrates, when thrown on red-hot coals, if nitric acid be present. In the London Pharmacopœia the detection of nitric acid is directed to be effected by immersing a plate of silver in the suspected acid: if nitric acid be present, a solution of nitrate of silver will be obtained, which is recognised by the white precipitate (*chloride of silver*) caused by the subsequent addition of hydrochloric acid. Pepper, or other acrid substances, may be detected by neutralizing the vinegar with carbonate of soda, when their acrid taste becomes very obvious.

2. *Wine Vinegar* (*Acetum Gallicum*, or *French Vinegar*, E.; *Acetum Vini*, D.)—In wine countries, vinegar is obtained from inferior wines. In France, wine vinegar is prepared in casks, which are placed in a stoved chamber, heated to between 68° and 77° F. Each vat communicates with the air by two apertures. Every eight or ten days the liquor in the vats must be changed. Either red or white wine may be used, but the latter is generally employed[y].

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[v] See Keïtzing, in the *Répertoire de Chimie*, t. iii. p. 263. Paris, 1838.

[w] See some remarks on these animalcules by Professor Owen, in the *Cyclopædia of Anatomy and Physiology*, vol. ii. p. 113. Lond. 1839.

[x] The Edinburgh College states, that "In four fluidounces [of British vinegar] complete precipitation takes place with thirty minims of Solution of Nitrate of Baryta," *Ph. Ed.* But Mr. Phillips (*Lond. Med. Gaz.* Aug. 3, 1839) has shown, that more than three times this quantity of nitrate is required.

[y] See Guibourt, *Histoire Abrégée des Drogues Simples*, 3rd ed. t. ii. p. 630, Paris, 1836; Ure's *Dictionary of Arts*, p. 3, Lond. 1839; and Donovan, *op. supra cit.* p. 328.

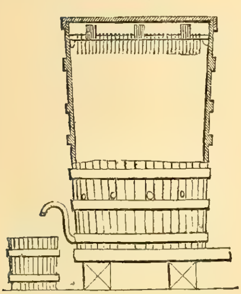
Wine Vinegar is of two kinds, *white* and *red*, according as it is prepared from white or red wine. *White wine vinegar* is usually preferred, as it keeps better. That which is made at Orleans is regarded as the best. According to the Edinburgh Pharmacopœia its density varies from 1·014 to 1·022. A sample of it, examined by Mr. Phillips, had a density of 1·016; and 100 minims of it saturated nearly 14 grains of crystallized carbonate of soda, while an equal quantity of English vinegar, exclusive of the sulphuric acid which it contains, saturated little more than 12 grains; consequently, the French is stronger than the English vinegar by nearly one-sixth[z].

The constituents of wine vinegar are very similar to those of malt vinegar. It contains a small quantity of bitartrate and sulphate of potash. Both these salts occasion precipitates with barytic solutions: but that produced by the bitartrate is soluble in nitric acid. The Edinburgh College states that "Ammonia, in slight excess, causes a purplish muddiness, and slowly a purplish precipitate. In four fluidounces, complete precipitation takes place with 30 minims of Solution of Nitrate of Baryta," *Ph. Ed.* But Mr. Phillips[a] has shown that this quantity of nitrate is more than twice as much as is requisite.

3. *Improved, German, or Quick Method of Vinegar-making.*—As acetification is essentially the oxidation of alcohol, the German chemists have contrived an improved method of effecting it, by which the time necessary to the production of vinegar is greatly curtailed. It consists in greatly enlarging the surface of the liquid exposed to the air.

This is effected by causing a mixture of one part of alcohol at 80 per cent., four to six parts water, $\frac{1}{1000}$ of ferment, honey, or extract of malt, to trickle down through a mass of beech shavings steeped in vinegar, and contained in a vessel called a *Vinegar Generator* (*Essigbilder*), or *Graduation Vessel.* It is an oaken tub, narrower at the bottom than at the top, furnished with a loose lid or cover, below which is a perforated shelf (colender or false bottom), having a number of small holes loosely filled with packthread about six inches long, and prevented from falling through by a knot at the upper end. The shelf is also perforated with four open glass tubes, as air vents, each having their ends projecting above and below the shelf. The tub, at its lower part, is pierced with a horizontal row of eight equidistant round holes, to admit atmospheric air. One inch above the bottom is a syphon-formed discharge pipe, whose upper curvature stands one inch below the level of the air-holes in the side of the tub. The body of the tub being filled with beech chips, the alcoholic liquor (first heated to between 75° F. and 83° F.) is placed on the shelf. It trickles slowly

FIG. 63.



Vinegar Generator.

(The upper part of the figure represents a vertical section of the tub.)

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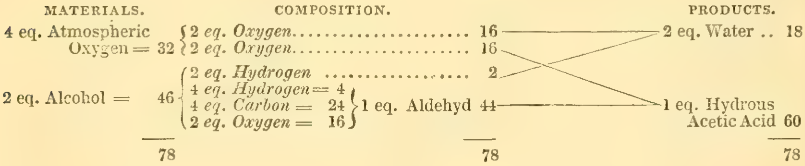
[z] *London Medical Gazette*, Aug. 3, 1839.

[a] *Op. supra cit.*

through the holes by means of the packthreads, diffuses itself over the chips, slowly collects at the bottom of the tub, and then runs off by the syphon pipe. The air enters by the circumferential holes, circulates freely through the tub, and escapes by the glass tubes. As the oxygen is absorbed, the temperature of the liquid rises to 100° or 104° F., and remains stationary at that point while the action goes on favourably. The liquid requires to be passed three or four times through the cask before acetification is complete, which is in general effected in from twenty-four to thirty-six hours[b].

Theory of Acetification.—A remarkable distinction between the acetous and vinous fermentation is, that for the former to be perfectly established, the presence of atmospheric air (or of oxygen) is essential, while for the latter this is not necessary. During the acetous fermentation the alcohol is converted into acetic acid, by the absorption of atmospheric oxygen. Two equivalents or 46 parts of alcohol, with four equivalents or 32 parts of atmospheric oxygen, contain the elements of one equivalent or 51 parts of anhydrous acetic acid, and of three equivalents or 27 parts of water; or one equivalent or 60 parts of hydrous acetic acid, and two equivalents or 18 parts of water.

According to Liebig, however, the transformation of alcohol into acetic acid is not immediate and direct. The atmospheric oxygen first oxidizes part of its hydrogen, forming water and aldehyd; and the latter absorbing oxygen, is converted into acetic acid.


MATERIALS.
COMPOSITION.
PRODUCTS.
4 eq. Atmospheric Oxygen = 32
2 eq. Oxygen........................ 16
2 eq. Oxygen........................ 16
2 eq. Water .. 18
2 eq. Hydrogen 2
2 eq. Alcohol = 46
4 eq. Hydrogen = 4
4 eq. Carbon = 24
2 eq. Oxygen = 16
1 eq. Aldehyd 44
1 eq. Hydrous Acetic Acid 60
78
78
78

The student will observe that the theory of acetification above given does not account for the evolution of carbonic acid during the process, and which is generally considered to be accidental, and not essential to the formation of acetic acid.

2. By the Destructive Distillation of Wood.—By the destructive distillation of the hard woods (oak, beech, hornbeam, ash, and birch), in iron cylinders, an impure acid, called Pyroligneous Acid, is obtained. The woods should be dried during several months. The lighter woods, as fir, and old ship timber, do not pay to distil, as the acid product is too weak.

Sometimes the still is a cast-iron cylinder, placed horizontally in a furnace, the fire of which plays around the cylinder, as in fig. 64.

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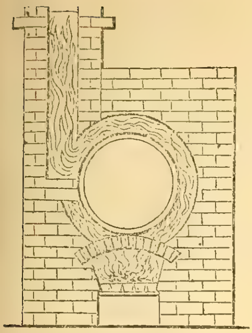
[b] For further details consult Ure's *Dictionary of Arts*, pp. 4 and 617; Mitscherlich, *Lehrbuch der Chemie*, Bd. 1^{er}, S. 549, 2^{te} Aufl. Berlin, 1834; and Liebig, in Turner's *Elements of Chemistry*, p. 876, 7th ed.

FIG. 64.



Section of a Pyroligneous Acid Still.

Another form of still is used at a large manufactory in the neighbourhood of London. It is a short cylinder of large diameter, placed upright in the furnace. The wood, cut up into convenient lengths, is introduced into wrought-iron canisters, in each of which is a hole, to allow of the escape of volatile matters. By the aid of a crane, these canisters are raised and deposited in the cylindrical still, the top of which is then carefully closed and made air-tight by luting. The still communicates with a large iron pipe which passes successively through two tanks of cold water, in which it is variously convoluted, and terminates in an underground reservoir, where tar and an acid liquor are deposited. The incondensible products are carbonic acid and some inflammable gases (carbonic oxide, light carburetted hydrogen, and olefiant gas), which escape. When no more volatile matter comes over, the still is opened, and the canisters being removed while still hot, the apertures in them are carefully closed by damp sand, to exclude air.

The *tar* obtained by the above process yields, on distillation, *oil of tar*, and a residuum called *English asphalt*, or *pitch.*

The *acid liquor*, which rests on the tar in the reservoir, consists of *acetic acid*, *water*, *tar*, and *pyroxilic spirit.* A light tarry matter usually floats on the top of it. By means of a pump, the acid liquor is raised and introduced into a copper still, where it is subjected to distillation. The first runnings contain pyroxilic spirit. After this has come over, an impure dilute acetic acid, called pyroligneous acid, distils over. The residue in the retort is English asphalt, or pitch.

The pyroligneous acid thus obtained is mixed with cream of lime, and the mixture evaporated to dryness in shallow wrought-iron pans, when it forms a greyish mass, called *pyrolignite of lime.* If this be submitted to distillation with sulphuric acid, it yields an impure acetic acid, which is used in the manufacture of acetate of lead, and for making carbonate of lead by the Dutch process.

If pyrolignite of lime be mixed with a solution of sulphate of soda, double decomposition is effected, and sulphate of lime and acetate of soda are the products. The latter is repeatedly crystallized until it is colourless, and is then in a fit state for the manufacture of pure con centrated acetic acid.

1. PYROXILIC SPIRIT; *Pyroligneous Ether; Hydrate of Oxide of Methule; Bihydrate of Methylene.* Sometimes, but improperly, termed *Naphtha.* The first runnings of the distillation of the acid liquor above referred to, are redistilled once or twice, and the product is sold under the name of *pyroligneous ether.* It is an impure liquor, containing, besides hydrate of the oxide of methule, acetone and other inflammable liquors. It is employed by chemists as a substitute for spirit of wine for burning in lamps, and by hatters and varnish-makers for dissolving resinous substances. Drs. Babington and Rees[c] have suggested its use for the

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[c] *Guy's Hospital Reports*, Oct. 1839; and *London Medical Gazette*, N. S. vol. i. for 1839-40.

preservation of subjects for anatomical purposes. The spirit is to be injected into the aorta, the rectum, and the peritoneum. It was tried at the London Hospital, but the smell arising from the spirit was so intolerable, that, even if there were no other objections to its use, this alone would be fatal to it.

Pure pyroxilic spirit is obtained by introducing it into a retort with excess of chloride of calcium, and distilling the mixture by a water-bath, as long as volatile matter passes off. A quantity of water, equal to the spirit employed, is then added, and the distillation continued. The product is now pure pyroxilic spirit, carrying along with it a little water, which is removed by a second distillation with quicklime (Liebig).

Pure pyroxilic spirit is a very mobile, colourless, inflammable liquid, which has a peculiar odour, somewhat resembling that of alcohol and acetic ether. It boils at 150° F. It dissolves many resins, mixes with most essential oils, and forms crystalline compounds with baryta, lime, and chloride of calcium. Its composition is as follows :—

	Atoms.	*Eq.Wt.*
Carbon	2	12
Hydrogen	4	4
Oxygen	2	16
Pyroxilic Spirit	1	32

Or,	*Atoms.*	*Eq.Wt.*
Oxide of Methule	1	23
Water	1	9
Hydrate of Oxide of Methule	1	32

Methule ($C^2 H^3$) is the hypothetical radical of pyroxilic spirit.

Oxide of Methule, or *Methylic Ether* ($C^2 H^3 O$) is a colourless gas.

The repeated use of small quantities of pyroxilic spirit caused colicy pains, and acted as an anthelmintic[cc].

2. Eblanin; *Pyroxanthine; Pyroxilene.*—This substance was obtained by Scanlan from raw pyroxilic spirit. It is a crystalline substance, of an orange red colour. Oil of vitriol dissolves it, and assumes a reddish blue colour. Concentrated hydrochloric acid also dissolves it, and acquires an intense purple colour[d]. Eblanin has the following composition :—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Carbon	21	126	75·45
Hydrogen	9	9	5·39
Oxygen	4	32	19·16
Eblanin	1	167	100·00

Preparation of Acetic Acid.—All the British colleges give directions for the preparation of a concentrated solution of acetic acid, which they simply term acetic acid.

The *London College* orders Acetate of Soda, lb. ij.; Sulphuric Acid, ℥ix.; Distilled Water, f℥ix. Add the sulphuric acid, first mixed with the water, to the acetate of soda put into a glass retort, then let the acid distil in a sand-bath. Care is to be taken that the heat, towards the end, be not too much increased.

The *Edinburgh College* gives the following directions:—"Take of Acetate of Lead any convenient quantity; heat it gradually in a porcelain basin, by means of a bath of oil, or fusible metal (8 tin, 4 lead, 3 bismuth) to 320° F.; and stir till the fused mass concretes again: pulverize this when cold, and heat the powder again to 320°, with frequent stirring, till the particles cease to accrete. Add six ounces of the powder to nine fluidrachms and a half of pure sulphuric acid, contained in a glass matrass: attach a proper tube and refrigeratory, and distil from a fusible-metal-bath, with a heat of 320°, to complete dryness. Agitate the distilled liquid with a grain or two of red oxide of lead to remove a little sulphurous acid; allow the vessel to rest a few minutes, pour off the clear liquor, and redistil it. The density should be not above 1·065."

The directions of the *Dublin College* are as follows:—Take of Acetate of Potash, 100 parts, Sulphuric Acid, 52 parts. Put the acid into a tubulated retort, then gradually, and at different intervals of time, add the Acetate of

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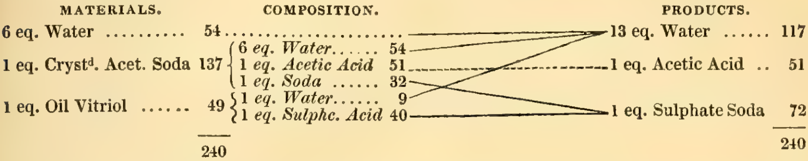
[cc] Dierbach, *Neuesten Entdeck. in d. Mat. Med.*, Bd. i. S. 314, 2te Ausg. 1837.

[d] For further details, see Thomson's *Chemistry of Organic Bodies*, p. 751. Lond. 1838.

Potash, waiting, after each addition, until the mixture becomes cool. Lastly, with a moderate heat, distil the acid until the residuum is dry. The specific gravity of this acid is to that of distilled water as 1·074 to 1·000.

The proportions of acetate of soda, sulphuric acid, and water, used by the London College, are nearly equal to one equivalent or 137 parts of crystallized acetate of soda, one equivalent or 49 parts of the strongest oil of vitriol (protohydrate of sulphuric acid), and six equivalents or 54 parts of water. The results of the distillation, on this calculation, will be the formation of one equivalent or 72 parts of anhydrous sulphate of soda, and the disengagement of one equivalent or 51 parts of anhydrous acetic acid, and thirteen equivalents or 117 parts of water.



The calculated results agree very closely with the actual products. The resulting acid consists of 51 real acetic acid and 114·58 water; so that 117—114·58 = 2·42 of water must remain in the retort with the sulphate of soda.

The Edinburgh College substitutes acetate of lead for acetate of soda. The salt is first dried to expel the water of crystallization, and the anhydrous salt thus obtained is subjected to distillation along with pure oil of vitriol, with the view, I presume, of obtaining glacial acetic acid. Hydrated acetic acid distils over, and sulphate of lead is left in the retort. To remove any sulphurous acid which may be formed, red oxide of lead is ordered to be added to the acetic acid, by which sulphate and sulphite of lead are formed, and the acetic acid is then to be redistilled [e].

The *Dublin College* employs acetate of potash to yield acetic acid. The reactions are similar to those of the London process.

The distillation of acetic acid is usually effected in glass or earthenware stills. On the large scale, silver condensers are sometimes used.

PROPERTIES.—*Glacial Acetic Acid* is the strongest acetic acid procurable. It crystallizes at 45° F. when we throw into it any particle of solid matter (a crystal of acetic acid answers best), and the thermometer plunged into it rises at the same time from 45° to 51°. These crystals are brilliant, broad flat plates, of a pearly lustre. They melt at a temperature somewhat below 60° F. The sp. gr. of the liquid at 60° is 1·06296.

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[e] The process of the Edinburgh Pharmacopœia has been critically examined by Mr. R. Phillips (*London Medical Gazette*, N. S. vol. ii. for 1839-40, p. 271). It cannot be denied that several unnecessary refinements have been introduced into it, which render the operation troublesome, wasteful, and expensive. Such are the use of a bath of oil or fusible metal,—the addition of red lead, and subsequent redistillation of the acid to get rid of a quantity of sulphurous acid, which, judging from the quantity of red oxide to be used, cannot exceed the $\frac{1}{2000}$ part of the product. Moreover, the whole process is objectionable on the ground that acid of this strength is not required for medicinal or pharmaceutical purposes.

When crystals of glacial acetic acid are dissolved in water we obtain a solution which, by way of distinction, we may denominate *liquid acetic acid*. The following table, drawn up by Dr. Thomson[f], shows the specific gravity of various atomic compounds of this acid and water:—

Acid.		*Water.*	*Sp. gr. at* 60°.
1 atom	+	1 atom	1·06296
1	+	2	1·07060
1	+	3	1·07084
1	+	4	1·07132
1	+	5	1·06820
1	+	6	1·06708
1	+	7	1·06349
1	+	8	1·05974
1	+	9	1·05794
1	+	10	1·05439

More recently Mohr[g] has published the following table, exhibiting the sp. gr. of acetic acid of different strengths:—

Per Cent. of Glacial Acid ($C^4 H^3 O^3$ + Aq.)	*Sp. Gr.*	*Per Cent. of Glacial Acid* ($C^4 H^3 O^3$ + Aq.)	*Sp. Gr.*	*Per Cent. of Glacial Acid* ($C^4 H^3 O^3$ + Aq.)	*Sp. Gr.*
100	1·0635	66	1·069	32	1·0424
99	1·0655	65	1·068	31	1·041
98	1·067	64	1·068	30	1·040
97	1·0680	63	1·068	29	1·039
96	1·069	62	1·067	28	1·038
95	1·070	61	1·067	27	1·036
94	1·0706	60	1·067	26	1·035
93	1·0708	59	1·066	25	1·034
92	1·0716	58	1·066	24	1·033
91	1·0721	57	1·065	23	1·032
90	1·0730	56	1·064	22	1·031
89	1·0730	55	1·064	21	1·029
88	1·0730	54	1·063	20	1·027
87	1·0730	53	1·063	19	1·026
86	1·0730	52	1·062	18	1·025
85	1·0730	51	1·061	17	1·024
84	1·0730	50	1·060	16	1·023
83	1·0730	49	1·059	15	1·022
82	1·0730	48	1·058	14	1·020
81	1·0732	47	1·056	13	1·018
80	1·0735	46	1·055	12	1·017
79	1·0735	45	1·055	11	1·016
78	1·0732	44	1·054	10	1·015
77	1·0732	43	1·053	9	1·013
76	1·073	42	1·052	8	1·012
75	1·072	41	1·0515	7	1·010
74	1·072	40	1·0513	6	1·008
73	1·072	39	1·050	5	1·0067
72	1·071	38	1·049	4	1·0055
71	1·071	37	1·048	3	1·004
70	1·070	36	1·047	2	1·002
69	1·070	35	1·046	1	1·001
68	1·070	34	1·045	0	1·000
67	1·069	33	1·044		

From these tables it is obvious that density is no criterion of the strength of liquid acetic acid.

The *Acidum Aceticum* of the Edinburgh Pharmacopœia is stated in one part of that work (p. 44) to have a sp. gr. of not above 1·065, in another (p. 2) to have a sp. gr. of not above 1·0685: moreover, in the same work, the density of the acid is said to be increased by [the addition of] 20 per cent. of water. There are, however, some obvious mistakes in these statements[h].

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[f] *First Principles of Chemistry*, vol. ii. p. 135.

[g] *Pharmaceutisches Central-Blatt* für 1839, S. 840-41.

The *Acidum Aceticum* of the London Pharmacopœia has a sp. gr. of 1·048. One hundred grains of it are saturated by eighty-seven grains of crystals of carbonate of soda. Hence it contains 30·8 per cent. of real or anhydrous acetic acid. It is a limpid, colourless liquid, having a pungent but agreeable odour, and an acrid taste. It possesses the usual properties of an acid;—such as reddening litmus, causing effervescence with the alkaline or earthy carbonates, and saturating bases. It is volatile, and by heat evolves an inflammable vapour.

Characteristics.—Free acetic acid is known by its peculiar odour and by its volatility. Its vapour reddens litmus, and fumes with ammonia. It does not occasion any precipitate with lime water, solutions of the barytic salts, or a solution of nitrate of silver. It forms with potash a very deliquescent salt. Concentrated acetic acid does not cause effervescence when marble is dropped into it, unless water be added.

The *neutral acetates* are all soluble, save those of molybdenum and tungsten. The acetates of silver and protoxide of mercury are slightly soluble. The acetates are known by the acetic odour which they emit on the addition of sulphuric acid, and by the white lamellar and pearly precipitates which many of them produce with the nitrate of silver and the protonitrate of mercury. They redden solutions of the sesquisalts of iron (forming *sesquiacetate of iron*). All the acetates are decomposed by heat, and give results which vary somewhat according to the nature of the base. Some of the acetates, as those of potash, lead, and copper, evolve, when heated, an inflammable fluid, called *acetone* or *pyro-acetic spirit*, whose composition is C^9, H^3, O^9.

COMPOSITION.—Anhydrous or real acetic acid consists of carbon, hydrogen, and oxygen, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Prout.*	*Berzelius.*
Carbon	4	24	47·06	47·05	46·83
Hydrogen	3	3	5·88	5·88	6·35
Oxygen	3	24	47·06	47·07	46·82
Anhydrous Acetic Acid	1	51	100·00	100·00	100·00

The *Acidum Aceticum* of the pharmacopœias is a compound of Anhydrous or Real Acetic Acid and Water. Prepared according to the London Pharmacopœia, 100 grs. of it contain 30·8 grs. of real acetic acid; or very nearly one equivalent of real acetic acid, and 13 equivalents of water.

	Atoms.	*Eq. Wt.*	*Theory.*	*Experiment.*
Anhydrous Acetic Acid	1	51	30·35	30·8
Water	13	117	69·65	69·2
Acidum Aceticum, *Ph. L.*	1	168	100·00	100·0

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[h] See Mr. R. Phillips, in the *London Medical Gazette*, N. S. for 1838-9, vol. ii; p. 688.

Owing to the errors before alluded to in the statements of the Edinburgh College, it is impossible to estimate, correctly, the strength of the acid intended to be obtained by the process given in the Edinburgh Pharmacopœia. If, however, the acid had a sp. gr. of 1·068, and 100 minims of it required 216 grs. of crystallized carbonate of soda to saturate it, as stated by the College, its per-centage quantity of real acetic acid would be 78·65.

ACETOMETRY.—The strength of acetic acid is best determined by ascertaining the quantity of alkaline carbonate which is required to saturate a given quantity of acid. Crystallized carbonate of soda, or crystallized bicarbonate of potash, are salts of uniform constitution, and may be employed for this purpose. Every 144 grs. of the crystallized carbonate of soda, or 101 grs. of crystallized bicarbonate of potash, are equal to 51 grs. of real acetic acid, or 60 grs. of glacial acetic acid. Marble or carbonate of lime is objectionable, since concentrated acetic acid will not decompose it without the addition of water.

I have already shown that specific gravity is no criterion of the strength of the hydrated acid; since two acids of very unequal strength may have the same density. Moreover, the foreign matters (*i. e.* mucilage and alcohol) contained in vinegar, alter the density of this fluid, though they do not affect its acetometrical strength. The acetometrical method employed by the Excise is that recommended by Messrs. J. and P. Taylor[i], and consists in estimating the strength of the acid by the sp. gr. which it acquires when saturated by hydrate of lime. Acid, which contains 5 per cent. of real acetic acid, is equal in strength to the best malt vinegar, called by the makers No. 24, and is assumed as the standard of vinegar strength, under the denomination of *proof vinegar*[j]. Acid, which contains 40 per cent. of real acetic acid, is, therefore, in the language of the revenue, 35 *per cent. over proof:* it is the strongest acid on which duty is charged by the Acetometer. Vinegars, which have not been distilled, contain mucilage, and require an allowance for the increase of weight from this cause. Hence in the Acetometer sold by Bate, a weight marked M is provided, and is used in trying such vinegars[k]. As the hydrate of lime employed causes the precipitation of part of the mucilaginous matter in the vinegar, it serves to get rid of part of the difficulty above referred to.

IMPURITIES.—The presence of sulphuric, hydrochloric, or nitric acid,—of metallic matter,—and of acrid substances in acetic acid, may be detected by the same methods as have already been pointed out for vinegar (see p. 390). Sulphurous acid is recognised by the white precipitate (*sulphate of lead*) produced on the addition of peroxide of lead. The presence of lead in acetic acid is known by the yellow precipitate (*iodide of lead*) occasioned by the addition of iodide of potassium.

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[i] *Quarterly Journal of Science,* vol. vi. p. 255.

[j] 58 Geo. 3. c. 65.

[k] See *Description of the Acetometer for determining the Strengths of Acetic Acid made for the Revenue of the United Kingdom,* by R. B. Bate, 21, Poultry, London.

Physiological Effects.—Before proceeding to notice the operation of acetic acid on vegetables and animals, it may be useful to point out such of its effects on *dead organic matters* as have reference to its influence on living beings. In the first place, it is a well-known and powerful antiseptic, and is employed, partly on this account, in the ordinary operation of pickling, and in the preservation of animal food, and of anatomical preparations. The impure acetic acid obtained in the distillation of wood, acts more efficaciously in this respect than the pure acid, on account of the creasote which it contains. Secondly, the action of acetic acid on albumen, fibrin, and blood-disks, deserves especial notice. Liquid albumen (as serum of blood and white of egg) is not coagulated by the ordinary acetic acid of the shops. Coagulated albumen is readily dissolved by it with the evolution of nitrogen, especially with the assistance of heat. Fibrin, as muscle or the crassamentum of the blood, also dissolve in it: the solution, by evaporation, yields a gelatiniform mass. Caseum is coagulated by it. It changes the form of the red particles of frog's blood, and dissolves part of the red colouring matter[l]. It is an excellent solvent of gelatine. Diluted and mixed with mucus, it acts as a digestive fluid[m].

α. *On Vegetables.*—Distilled vinegar is ranked, by Achard, among vegetable poisons[n]

β. *On Animals generally.* — Concentrated acetic acid acts as a caustic poison to dogs. It causes blackening of the mucous lining of the stomach, analogous to that produced by sulphuric acid[o]. Four or five ounces of common vinegar proved fatal to dogs in ten or fifteen hours, when vomiting was prevented by tying the œsophagus[p]. Injected into the veins, vinegar does not appear to act energetically. Viborg threw two ounces and a half of wine vinegar into the jugular vein of a horse: the next day the animal was well[q]. Analogous results have been obtained by Courten and Hertwich (quoted by Wibmer) and by Pommer[r].

The impure acetic acid obtained by the distillation of wood, has been usually regarded as possessing much more activity than pure acetic acid of the same strength, in consequence of the presence of empyreumatic oil. An extensive series of experiments have been made with it on amphibials, birds, and mammals, by Berres, Kerner, and Schubarth. From these it appears that pyroligneous acid is a caustic poison; and that it destroys some of the lower animals, viz. amphibials, merely by contact with the external skin. Large doses affect the cerebro-spinal system, and cause giddiness, insensibility, paralysis, and convulsions. A very constant effect of it was an affection of the windpipe and lungs. The acid was detected by its odour, in the blood and secretions[s].

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[l] Müller's *Physiology*, p. 106.
[m] Müller, *op. cit.* p. 545.
[n] De Candolle, *Phys. Végét.*
[o] Orfila, *Journ. de Chim. Méd.* t. vii. p. 449.
[p] *Ibid.*
[q] Wibmer, *Die Wirkung der Arzneimittel. und Gifte*, Bd. i. S. 11.
[r] Christison, *Treatise on Poisons.*

γ. *On Man.*—In the concentrated state acetic acid is an irritant and corrosive poison (see p. 214). Its chemical influence depends principally on its power of dissolving fibrin, albumen, and gelatine, as before mentioned, by which it is enabled to dissolve many of the animal tissues. Applied to the skin it acts as a rubefacient and vesicant (see p. 215). Only one fatal case of poisoning by its internal use is known. The patient (a girl) appeared to be intoxicated, complained of acute pain, and was violently convulsed[t].

Swallowed in a very dilute form, and in moderate doses, it proves refreshing, allays thirst, diminishes preternatural heat, lowers the pulse, and augments the urine. In its general effects, therefore, it appears to lower the powers of life and to prove antiphlogistic. It agrees in its operation with the diluted mineral acids (see pp. 189, 193, 201, and 212). Its local operation is astringent. Used moderately it assists the digestive process, and is, therefore, taken as a condiment. It is in repute with young ladies for diminishing obesity. "Every one knows," says Giacomini[u], "that when habitually taken, it produces leanness, from a sort of languor of the digestive process." The following is a case, quoted by this author, from Portal:—

> "A few years ago, a young lady, in easy circumstances, enjoyed good health; she was very plump, had a good appetite, and a complexion blooming with roses and lilies. She began to look upon her plumpness with suspicion; for her mother was very fat, and she was afraid of becoming like her. Accordingly, she consulted a woman, who advised her to drink a small glass of vinegar daily: the young lady followed her advice, and her plumpness diminished. She was delighted with the success of the remedy, and continued it for more than a month. She began to have a cough; but it was dry at its commencement, and was considered as a slight cold, which would go off. Meantime, from dry it became moist; a slow fever came on, and a difficulty of breathing; her body became lean, and wasted away; night-sweats, swelling of the feet and of the legs, succeeded, and a diarrhœa terminated her life. On examination, all the lobes of the lungs were found filled with tubercles, and somewhat resembled a bunch of grapes."

It is said that the long-continued use of it, in full doses, will induce chronic diseases of the gastro-intestinal mucous membrane; and Morgagni says, it has even given rise to scirrhus of the pylorus.

Vinegar may be taken in considerable quantity at one time without inconvenience. Dr. Christison[v] knew a case in which eight ounces were swallowed without injury.

The vapour of strong acetic acid is very pungent and irritating. The long-continued inhalation of acetic vapours by the workmen employed at vinegar-works, is said by Sundelin[w] to be injurious to the lungs, and to bring on chronic inflammation of these organs. On inquiry among the workmen of a large vinegar-manufactory, I find the notion of the injurious influence of the vapour generally repudiated.

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[s] Wibmer, *op. supra cit.*
[t] Orfila, *Journ. Chim. Méd.* t. ii.
[u] *Lond. Med. Gaz.*, N. S. vol. ii. for 1838-9, p. 175.
[v] Christison, *Treatise on Poisons.*
[w] *Handb. d. Heilmittellehre.*

Both at these works, and at a pyroligneous acid manufactory, the workmen appeared in excellent health.

Uses.—The uses of acetic acid and vinegar, to the medical practitioner, are of two kinds,—medicinal and pharmaceutical.

1. *Medicinal.*—Taken internally, common vinegar, or acetic acid properly diluted, is used for various purposes: the most important of these are, to allay febrile heat by its refrigerant qualities; to diminish inordinate vascular action; to relieve certain affections of the brain supposed to depend on, or be connected with, venous congestion; and to act by its chemical properties of an acid. Thus, in *fevers*, whether simple or eruptive, but especially in those varieties commonly denominated putrid and bilious, vinegar (more or less diluted with water) is a most refreshing drink, allaying thirst, and diminishing excessive heat. In *hemorrhages*, as from the nose, lungs, stomach, or uterus, it is particularly beneficial by its refrigerant, sedative, and astringent qualities. It diminishes excessive vascular action, and promotes contraction of the bleeding vessels. As a local astringent, it is injected into the nose in epistaxis, and is used as a wash in profuse hemorrhoidal discharges. The benefit obtained by the application of vinegar and water to the abdomen, vulva, and thighs, in uterine hemorrhages, arises principally from the cold produced. In *phthisis pulmonalis*, vinegar, diluted with water, is sometimes serviceable as a palliative, by its refrigerant qualities: it relieves the hectic symptoms, diminishes or puts a stop to the night sweats, checks bronchial hemorrhage, and prevents diarrhœa. In *mania*, it has been recommended as a means of allaying cerebral excitement. In *poisoning by opium*, it is used as a counter-poison; but as acetic acid forms very soluble, and, therefore, powerful compounds with morphia, it ought not to be exhibited until the contents of the stomach have been evacuated. In poisoning by the alkalis, and their carbonates, and by lime, vinegar is the safest and most efficacious acidulous substance that can be administered. In diseases attended with *phosphatic deposits* in the urine, it may be advantageously used either as a medicine or condiment. *As an adjunct to the acetate of lead*, acetic acid is recommended by Dr. A. T. Thomson, to prevent the formation of carbonate of lead, which is more apt to produce lead colic than the acetate. In *scurvy*, acetic acid has been found serviceable. *Clysters containing vinegar* have been employed for the purpose of provoking alvine evacuations in obstinate constipation and strangulated hernia; of expelling the small round worm (*Ascaris vermicularis*); of checking uterine and intestinal hemorrhage; and of relieving inflammation or congestive conditions of the brain.

As a stimulant, disinfectant, and antiseptic, diluted acetic acid is used in gangrenous and other ill-conditioned ulcers. For these purposes crude pyroligneous acid is more efficacious than ordinary vinegar, on account of the creasote and other substances which it contains. In ulceration of the throat, in scarlatina, and in cynanche, gargles containing acetic acid or vinegar are sometimes used with good effect. Acetic collyria are useful, as mild astringents, in chronic ophthalmia, and for removing lime-dust adhering to any part of the globe or lid of the eye.

Sponging the face, trunk, or extremities, with cold or tepid vinegar and water, usually proves refreshing and grateful in febrile disorders with a hot skin. It diminishes preternatural heat, promotes the cutaneous functions, and operates as a beneficial stimulant to the nervous system.

Fomentations containing vinegar are used in bruises, sprains, &c.

The concentrated acetic acid, known in the shops as Beaufoy's, is a valuable remedy for the cure of the different forms of porrigo, popularly called ring-worm or scalled head. Its application, which may be effected by means of a piece of lint wrapped around a wooden stick, causes acute but temporary pain, redness of the skin, and whitening of the abraded spots. One or two applications are usually sufficient to effect a cure. Strong acetic acid is also employed as a caustic to destroy corns and warts. It has been proposed as a speedy means of exciting rubefaction and vesication, and, for this purpose, blotting-paper or cambric, moistened with this acid, has been applied to the neck in cases of croup.

Administration.—Vinegar is used as a condiment *ad libitum.* Medicinally it is given in doses of from fʒj. or fʒij. to f℥ss. As an enema f℥j. or f℥ij. have been used. A refrigerant drink in fevers is made by adding f℥j. or f℥ij. of vinegar to a quart of water. A vinegar wash is prepared by mixing f℥iij. of vinegar and f℥v. of water.

Antidotes.—In poisoning by strong acetic acid, the treatment is the same as that for poisoning by other acids. (See p. 281. Also *Acidum Sulphuricum*).

1. ACETUM DESTILLATUM, L. E. D. *Distilled Vinegar.*—All the British colleges give directions for the preparation of this liquid.

The *London College* directs us to take of Vinegar a gallon. Let the Vinegar distil in a sand-bath, from a glass retort into a glass receiver. Keep the seven pints first distilled for use.

The *Edinburgh College* says, "Take of Vinegar (French, by preference) eight parts: distil over with a gentle heat six parts: dilute the product, if necessary, with distilled water till the density is 1·005."

The *Dublin College* takes of Wine-vinegar, *by measure,* ten parts. Distil with a slow fire eight parts by measure. In the distillation, glass vessels should be employed, and the first portion which comes over, in quantity amounting to one part, rejected.

The first portions which distil over are alcohol, acetic ether, water, and a little acetic acid. Hence the Dublin College directs the first tenth part to be rejected. Prepared according to the pharmacopœias, distilled vinegar has a yellowish tint, and contains, besides acetic acid and water, a little alcohol, acetic ether, and an organic substance called mucilage. Hence, when it is saturated with alkalis, the solution becomes brown by heat, and deposits a dark-coloured substance, probably arising from the decomposition of the mucilage.

One hundred grains of *acetum destillatum,* Ph. Lond. saturate thirteen grains of crystals of carbonate of soda. This indicates the per-centage quantity of real acetic acid in it to be 4·6. But the *acetum destillatum*, Ph. Ed. is not so strong, in consequence of the College directing only ⅞ths of the vinegar to be distilled. Its density is stated to be 1·005; and one hundred minims of it neutralize eight grains of crystallized carbonate of soda, indicating the per-centage quantity of real acid to be 3·07[x].

In order to prevent the distilled vinegar from acquiring a metallic impregnation, the head of the still and the worm or condensing pipe should be of glass or earthenware. I was informed at one vinegar works that a silver worm was employed.

A mixture of acetic acid and water may be advantageously substituted for distilled vinegar. If the acetic acid be of the strength directed in the London Pharmacopœia, the proportions will be, of acetic acid 15 parts, of water 85 parts, to form a dilute acid equal in strength to that of distilled vinegar.

The effects and uses of distilled vinegar have been noticed under the head of Acetic Acid.

2. **ACIDUM ACETICUM AROMATICUM,** *E.*—(Rosemary, and Origanum, of each ℥j., dried; Lavender, dried, ℥ss.; Cloves, bruised, ʒss.; Acetic Acid, Oiss. Macerate for seven days, strain and express strongly, and filter the liquor). In the former Edinburgh Pharmacopœia there was contained, under the same name, a somewhat similar but weaker preparation, made with *diluted* acetic acid (*i. e.* distilled vinegar), in imitation of the celebrated *Marseilles Vinegar*, or *Vinegar of the Four Thieves*[y] (*Vinaigre des Quatre-Voleurs; Acetum quatuor Furum*), once supposed to be a prophylactic against the plague and other contagious diseases. It was a very useless preparation. In the present Edinburgh Pharmacopœia, concentrated acetic acid has been substituted for distilled vinegar, and Origanum for Sage. It is now a pungent perfume, and may be used as a substitute for *Henry's Aromatic Vinegar*. But it appears to me to be a very unnecessary preparation.

The *Acetum aromaticum*, or *Aromatic Vinegar* of the shops, is made in imitation of Henry's Aromatic Vinegar. At Apothecaries' Hall it is prepared by dissolving the Oils of Cloves, Lavender, Rosemary, and Acorus Calamus, in crystallizable Acetic Acid. It is a very volatile and corrosive preparation, and requires to be kept in carefully-stoppered bottles. Some manufacturers add camphor. The addition of water to it causes the precipitation of the greater part of the camphor. It is a much perfumed pungent perfume, whose vapour is snuffed up the nostrils, to produce a powerful excitant impression, in fainting, languor, headache, and nervous debility. For this purpose it is dropped on sponge, which is preserved in smelling-bottles or *vinaigrettes.* It is also used for the purpose of correcting unpleasant odours, which it does, not by destroying, but by disguising them (see p. 217). *An extemporaneous aromatic vinegar* may be prepared by putting into a stoppered bottle fʒj. of acetate of potash, three drops of some essential oil (as Lavender or Lemon), and twenty drops of oil of vitriol.

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[x] See Mr. R. Phillips, in *London Medical Gazette*, N. S. vol. ii. for 1838-39, p. 688; and vol. ii. for 1839-40, p. 271.

[y] "The repute of this preparation as a prophylactic in contagious fevers, is said to have arisen from the confession of four thieves, who, during the plague of Marseilles, plundered the dead bodies with perfect security, and, upon being arrested, stated, on condition of their lives being spared, that the use of aromatic vinegar had preserved them from the influence of contagion. It is on this account sometimes called "Le Vinaigre des quatre Voleurs." It was, however, long used before the plague of Marseilles, for it was the constant custom of Cardinal Wolsey to carry in his hand an orange, deprived of its contents, and filled with a sponge which had been soaked in vinegar impregnated with various spices, in order to preserve himself from infection, when passing through the crowds which his splendour or office attracted. The first plague raged in 1649, whereas Wolsey died in 1531." (Paris, *Pharmacologia*, vol. ii. p. 18, 6th ed. Lond. 1825).

3. **ACIDUM ACETICUM CAMPHORATUM,** E. D. (Camphor, ℥ss.; Acetic Acid, f℥viss. [f℥vj. *D.*] Pulverize the camphor with the aid of a little rectified spirit, and dissolve it in the acid).—This preparation is an officinal substitute for *Henry's Aromatic Vinegar.* The spirit is used merely to assist in reducing the camphor to powder. Camphorated acetic acid is exceedingly pungent and corrosive. Its vapour is snuffed up the nostrils as a powerful stimulant in syncope. It is never used internally.

4. **OXYMEL,** L. D. *Syrupus Aceti,* E.; *Oxymel Simplex* or *Simple Oxymel.* (The *London College* directs of Honey [clarified], lb. x.; Acetic Acid, Oiss. Mix the acid with the honey made hot[z].—The *Dublin College* orders of Honey, by weight, lb. ij.; Distilled Vinegar, Oj. [*wine measure*]. Boil them in a glass vessel, with a slow fire, to the thickness of syrup, removing the scum.—The *Edinburgh College* substitutes sugar for honey:—Take of Vinegar, French in preference, f℥xj.; Pure Sugar, ℥xiv. Boil them together).—It is employed as a detergent and pectoral. It is frequently added to gargles; but is more commonly used as an expectorant in slight colds and coughs. Diffused through barley-water, it forms an agreeable refrigerant drink in febrile and inflammatory complaints. It is sometimes used as a vehicle for other medicines. Dose from ʒj. to ℥ss. or ℥j.

2. *Pharmaceutical Uses.*—Vinegar or acetic acid is employed for extracting the virtues of various medicinal substances, as Squills, Opium, Colchicum, and Cantharides: the solutions are called *Medicated Vinegars* (*Acetica*), or, by the French pharmacologists, *Oxéolés* (from ὄξος, vinegar). A small quantity of spirit is usually added to them for the purpose of preventing the decomposition of the vinegar, and, in consequence of this, a small portion of acetic ether is generated. They are usually prepared by maceration. The preparations into the composition of which acetic acid and honey enter, are called *Oxymels* (*Oxymellites*), or the *Acid Mellites.* Acetic acid is employed also in the manufacture of the salts called *Acetates.* It is a powerful solvent of the gum-resins, and is used, on this account, in the preparation of the *Emplastrum Ammoniaci.* Lastly, distilled

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[z] There is a mistake in the formula of the London College; the quantity of acetic acid directed to be used being much too large. Prepared according to the London Pharmacopœia, oxymel is an acrid preparation. The quantity of acetic acid employed should be sufficient to give the preparation an agreeable flavour. When the honey is very thick, a little water should be employed. A very fine oxymel, which I examined, was prepared with 132 lbs. 12 oz. of honey, and 8 lbs. 2 oz. (*Avoirdupois*) of acetic acid.

vinegar is used in the preparation of Cataplasma Sinapis, Ceratum Saponis, Linimentum Æruginis, and Unguentum Plumbi compositum.

8. AC'IDUM CI'TRICUM, *L. E. D.*—CITRIC ACID.

History.—This acid was first procured in the solid state by Scheele in 1781. It is sometimes termed the *Concrete Acid of Lemons*.

Natural History.—Citric acid is peculiar to the vegetable kingdom.

It is found in many acid juices of fruits usually free, but sometimes in combination with either potash or lime. Besides the fruits of the genus *Citrus*, it is found, with little or no malic acid, in the fruits of Dulcamara, Dog-rose, Cranberry, Bird-cherry, and Whortleberry. Mixed with an equal quantity of malic acid, it is found in the Gooseberry, Red Currant, Strawberry, Raspberry, Cherry, &c. In the Tamarind it exists with both malic and tartaric acids.

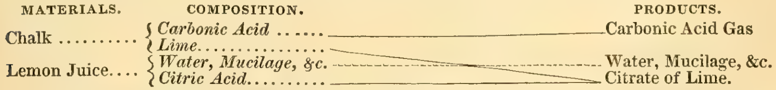
Preparation.—All the British colleges give directions for the preparation of this acid.

The *London College* orders of Lemon Juice, Oiv.; Prepared Chalk, ℥ivss.; Diluted Sulphuric Acid, f℥xxviiss.; Distilled Water, Oij. Add the Chalk gradually to the Lemon Juice made hot, and mix. Set by, that the powder may subside: afterwards pour off the supernatant liquor. Wash the Citrate of Lime frequently with warm water. Then pour upon it the diluted Sulphuric Acid and the distilled Water, and boil for a quarter of an hour. Press the liquor strongly through linen, and strain it; evaporate the strained liquor with a gentle heat, and set it by, that crystals may be formed. Dissolve the crystals, that they may be pure, again and a third time in water, and as often strain the solution, boil down and set it aside.

The *Edinburgh College* employs the same quantity of Lemon Juice and Chalk (or of the latter a sufficiency), and "Diluted Sulphuric Acid, f℥xxvii., or in the same proportion to the chalk required[a]." The lemon juice is to be boiled twice, and allowed to rest once before the chalk is added. After the sulphuric acid has been added, the filtered liquor is to be tested with a solution of nitrate of baryta, and if the precipitate thereby obtained be not "almost entirely soluble in nitric acid," more citrate of lime is to be added [to saturate the great excess of sulphuric acid].

The process of the *Dublin College* is essentially similar to that of the London College.

The juice of lemons and limes is imported for citric acid manufacturers, in pipes and hogsheads. It is saturated with chalk or whiting in a large vat. By this means a citrate of lime is formed. This is precipitated, while the carbonic acid of the chalk escapes, and the mucilage of the juice for the most part remains in solution.



The supernatant liquor is then drawn off, and the citrate of lime is passed through a sieve and frequently washed with warm water, until the mucilage and other soluble impurities are for the most part got rid of. Sulphuric acid, diluted with water, is afterwards added: sulphate of lime separates, and citric acid is left in solution.

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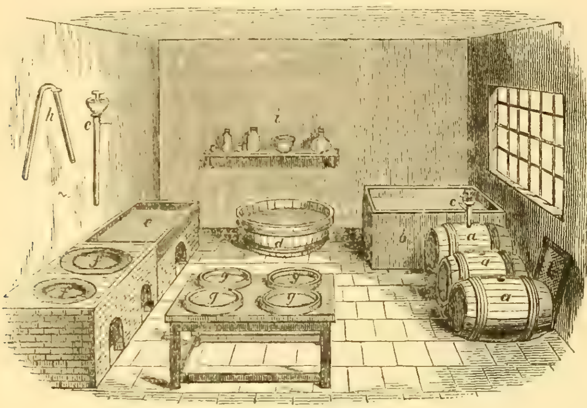
[a] The Edinburgh College employs half an ounce of diluted sulphuric acid less than the London College; whereas, it ought to have been increased by eight ounces, in consequence of the diluted sulphuric acid of the Edinburgh Pharmacopœia being weaker than that of the London Pharmacopœia (Mr. R. Phillips, *London Medical Gazette*, N. S. vol. ii. 1838-9, p. 690.)

MATERIALS.	COMPOSITION.	PRODUCTS.
Citrate of Lime..	*Citric Acid..*	Citric Acid.
	Lime	
Sulphuric Acid		Sulphate of Lime.

The clear solution is then evaporated in leaden boilers, and the concentrated solution set aside to crystallize. The crystals are afterwards purified by re-solution and re-crystallization[b].

Fig. 65.

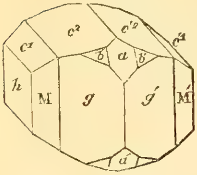


Citric Acid Manufactory.

a, a, a. Casks of Lemon Juice.
b. Wooden Vat for saturating the juice with chalk.
c, c. Copper Pumps.
d. Decomposing Tub for the citrate of lime and sulphuric acid.
e. Leaden Boiler.
f, f. Finishing Leaden Boilers.
g. Crystallizing Pans.
h. Leaden Syphon for running off the waste liquor from the vat *b*.
i. Chemical Tests.
k. Moveable Strainer for clearing the mother liquors.

PROPERTIES.—Citric acid crystallizes in colourless, odourless, very sour, transparent, short, rhomboidal prisms, whose extremities are terminated by four trapezoidal faces, and which belong to the right prismatic system[c]. Crystallized citric acid becomes damp by exposure to a moist atmosphere, though Dumas, and other French chemists, state it to be unalterable by the air. According to Vauquelin, it is soluble in 75 parts of cold and 50 of boiling water. The solution is strongly acid, and becomes mouldy by keeping. Crystallized citric acid is much less soluble in alcohol than in water. Its sp. gr. is 1·617. Heated with potash, it is converted into oxalic and acetic acids and water. Treated with oil of vitriol it

Fig. 66.



Crystal of Citric Acid.

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[b] For further details, consult Parkes's *Chemical Essays*, vol. i. p. 539, 2d ed. 1823.
[c] Brooke, *Annals of Philosophy*, N.S. vol. vi. p. 119.

evolves sulphurous acid, carbonic acid, carbonic oxide, acetic acid, and water. Heated with nitric acid, it becomes oxalic acid.

According to Crasso, crystallized citric acid, when exposed to heat, exhibits four stages of decomposition. During the first, the water of crystallization alone is given off, and the residue contains unaltered citric acid. The second stage is characterized by white vapours, and the production of acetone, carbonic oxide, and carbonic acid, while the residue consists of hydrated aconitic acid ($C^4 H O^3 + Aq.$), which is the true pyrocitric acid. In the third stage, the aconitic acid, not being volatile, is itself decomposed, yielding carbonic acid and an oily liquid which soon crystallizes. This is the pyroaconitic acid, the citricic of Baup, for which Crasso proposes the name of itaconic acid ($C^5 H^2 O^3 + H O$). This acid, when heated, yields citraconic acid ($C^5 H^2 O^3 + H O$), the citribic acid of Baup. In the fourth period empyreumatic oil is produced, and a voluminous coal remains behind[d].

Characteristics.—When added in excess to lime water, no precipitate is produced. "When a few drops of a solution of citric acid are added to lime water, a clear liquid results, which, when heated, deposits a white powder, soluble in acids without effervescence," (Liebig). It does not yield a crystalline precipitate when added in excess to a solution of carbonate of potash. It forms, with barytic water, a white precipitate (*citrate of baryta*). With a solution of acetate of lead it also furnishes a white precipitate (*citrate of lead*), soluble in ammonia, which forms with it a double salt (*ammoniacal citrate of lead*). Added to a solution of nitrate of silver it produces a white precipitate (*citrate of silver*), which, when heated, becomes brown, froths up, deflagrates, discharges white fumes, and leaves an abundant, ash-grey, coarsely fibrous, crumbly residue, which by heat becomes pure silver.

Composition.—The following is the composition of crystallized citric acid:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Dumas.*	*Prout.*	*Ure.*
Carbon	4	24	35·8	36·28	34.28	33·00
Hydrogen	3	3	4·5	4·45	4·76	4·63
Oxygen	5	40	59·7	59·27	60·96	62·37
Citric Acid crystallized by cooling a solution saturated at 212°	1	67	100·0	100·00	100·00	100·00

Crystallized citric acid of commerce contains, however, somewhat more oxygen and hydrogen (elements of water) than the above:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Dumas.*
Carbon	4	24	34·29	34·75
Hydrogen	$3\frac{1}{3}$	3·33	4·76	4·72
Oxygen	$5\frac{1}{3}$	42·66	60·95	60·53
Commercial Citric Acid, or Acid formed at 61°	1	70·00	100·00	100·00

According to Berzelius, hypothetical dry citric acid is composed of

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[d] Crasso, quoted by Liebig, in Turner's *Elements of Chemistry,* 7th ed.

$C^4 H^2 O^4$ (= 58); and, therefore, the acid, crystallized by cooling, consists of $\overline{Ci}$ + Aq. (58 + 9 = 67), and the commercial acid of $\overline{Ci} + 1\frac{1}{3}$ Aq. (58 + 12 = 70).

But Liebig[e] regards the hypothetical dry citric acid as composed of $C^{12} H^5 O^{11}$ (= 165). On this supposition, the acid, crystallized by cooling, is composed of $\overline{Ci} + 3HO$ + Aq. (165 + 36 = 201); and the commercial crystals of $\overline{Ci} + 3HO + 2$ Aq. (165 + 45 = 210). On this view of its constitution citric acid is a tribasic acid: that is, it combines with three equivalents of base: its equivalent weight being three times the amount assumed in the above tables.

PURITY.—Powdered citric acid is sometimes adulterated with powdered tartaric acid. The fraud may be readily detected by dissolving the suspected acid in a small quantity of water, and adding cautiously to it a solution of carbonate of potash, taking care that the acid be in excess. If any tartaric acid be present, a white crystalline precipitate (*bitartrate of potash*) is formed. The directions of the London and Edinburgh Colleges for ascertaining the purity of the acid are as follows:—

> This acid is soluble in water; what is precipitated from the solution by acetate of lead is dissolved by nitric acid. No salt of potash, except the tartrate, is precipitated by solution of citric acid. It is totally dissipated in the fire (*Ph. Lond.*)

The solubility of the plumbeous precipitate in nitric acid shows the absence of sulphuric acid or a sulphate.

> A solution, in four parts of water, is not precipitated by carbonate of potash: when incinerated with the aid of the red oxide of mercury, no ash is left, or a mere trace (*Ph. Ed.*)

The elements of citric acid (viz. oxygen, hydrogen, and carbon) are dissipated by a red heat. But this dissipation is promoted by agents (*ex.* red oxide of mercury) capable of supplying oxygen without leaving any fixed residuum.

PHYSIOLOGICAL EFFECTS.—Orfila[f] ranks citric acid among the irritant poisons; but Drs. Christison[g] and Coindet gave drachm doses of it to cats without observing that the animals suffered any inconvenience therefrom. The effects of large doses of this acid on man I am not acquainted with. Small quantities of it, dissolved in water, form an agreeable beverage, which allays thirst, diminishes preternatural heat, checks profuse sweating, and promotes the secretion of urine[h]. Vogt[i] considers it to act more powerfully on the skin, and less so on the alimentary canal and urinary organs, than tartaric acid. In its action on the skin it agrees with acetic acid. The continued employment of it, as well as of other acids, disturbs the functions of the digestive organs[j].

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[e] Turner's *Elements of Chemistry*, 7th edit.

[f] *Toxicologie Générale.*

[g] Christison, *On Poisons*, p. 208, 3rd edit.

[h] See pp. 193, 201, and 212.

[i] *Pharmakodyn.* Bd. ii. S. 72. 2te Aufl.

[j] For some further observations on its effects, see the article *Lemon Juice*, in a subsequent part of this work.

Uses.—Citric acid is employed in medicine, as a substitute for lemon juice, in the preparation of refrigerant drinks and effervescing draughts, and as antiscorbutic, anti-narcotic, and anti-alkaline. (See *Lemon Juice*.)

1. **ARTIFICIAL LEMON JUICE.**—This is prepared by dissolving Citric Acid ʒviijss., in Water f℥xvj., and flavouring with a few drops of Essence of Lemons. This is less apt to undergo decomposition than the genuine juice, for which the artificial juice may be employed in the preparation of cooling beverages.

2. **EFFERVESCING CITRATES.**—Citric acid, with the alkaline carbonates, is frequently employed in the preparation of effervescing draughts. The following are the relative proportions of acid and base required to form a neutral compound.

20 *grs. of Commercial Crystals of Citric Acid are saturated by about*—

Crystallized Bicarbonate of Potash....	29 grs.
Carbonate of Potash of Commerce	24 „
Hydrated Sesquicarbonate of Ammonia	17 „
Crystallized Carbonate of Soda	41 „
Sesquicarbonate of Soda of Commerce	24 „

The most agreeable effervescing citrate is that prepared with bicarbonate of potash, flavoured with tincture of orange peel and syrup (see *Potassæ Citras*). Sometimes an effervescing citrate is prepared with the hydrated sesquicarbonate of ammonia (see *Ammoniæ Citras*, p. 326). The carbonates of soda are rarely employed with citric acid.

9. AC′IDUM TARTAR′ICUM, *L. E. D.*—TARTARIC ACID.

History.—Tartaric acid was first procured in a separate state by Scheele, in 1770. It is sometimes termed the *crystallized acid of tartar*.

Natural History.—It is peculiar to the vegetable kingdom.

In the *free* state it exists in tamarinds, grapes, the pine-apple, and pepper. It is also found native in combination with bases: thus, *bitartrate of potash* exists in tamarinds, grapes, mulberries, &c., and *tartrate of lime* in the fruit of *Rhus typhinum.*

Preparation.—All the British colleges give formulæ for its preparation.

The *London College* directs us to take of Bitartrate of Potash, lb. iv.: Boiling Distilled Water, *Cong.* iiss.; Prepared Chalk, ℥xxv. and ʒvj.; Diluted Sulphuric Acid, Ovij. and f℥xvij.; Hydrochloric Acid, f℥xxviss., or as much as may be sufficient. Boil the Bitartrate of Potash with two gallons of Distilled Water, and add, gradually, half the prepared Chalk; then, the effervescence having ceased, add the remainder of the Chalk, previously dissolved in the Hydrochloric Acid with four pints of the Distilled Water. Lastly, set aside, that the Tartrate of Lime may subside; pour off the liquor, and wash frequently the Tartrate of Lime, with Distilled Water, until it be void of taste; then pour on it the diluted Sulphuric Acid, and boil for a quarter of an hour. Evaporate the strained liquor by a gentle heat, that crystals may be formed.

Dissolve the crystals, that they may be pure, again, and a third time, in water, and, as often, strain the liquor, boil down, and set it aside.

The process of the *Edinburgh Pharmacopœia* is essentially the same [k].

The *Dublin College* uses of Bitartrate of Potash, reduced to powder, ten parts; Prepared Chalk, four parts; Sulphuric Acid, seven parts; Water, one hundred and twenty parts. The process is otherwise similar to that of the London Pharmacopœia.

The following is the *theory* of the process for making tartaric acid:—By the mutual action of bitartrate of potash and carbonate of lime (chalk), we obtain tartrate of potash in solution and tartrate of lime precipitated, while carbonic acid escapes.—The following diagram explains these changes:—

MATERIALS.	COMPOSITION.		PRODUCTS.
1 eq. Chalk = 50	1 *eq. Carbonic Acid..*	22	1 eq. Carbonic Acid = 22
	1 *eq. Lime..........*	28	
1 eq. Bitartrate Potash = 180	1 *eq. Tartrate Potash*	114	1 eq. Tartr^te Potash = 114
	1 *eq. Tartaric Acid..*	66	1 eq. Tartrate Lime = 94
230		230	230

If to the solution of tartrate of potash we add chloride of calcium (obtained by dissolving chalk in hydrochloric acid), double decomposition ensues; tartrate of lime is precipitated, and chloride of potassium remains in solution.

MATERIALS.	COMPOSITION.				PRODUCTS.
1 eq. Chlor. Calcium = 56	1 *eq. Chlorine................*		36		1 eq. Chlor. Potas^m = 76
	1 *eq. Calcium................*		20		
1 eq. Tartrate Potash = 114	1 *eq. Potash* 48	1 *eq. Potassium*	40		
		1 *eq. Oxygen..*	8	1 *eq. Lime* 28	1 eq. Tartr^e Lime = 94
	1 *eq. Tartaric Acid...........*		66		
170			170		170

The tartrate of lime obtained in the above two operations is then decomposed by sulphuric acid, which forms the almost insoluble sulphate of lime, and sets tartaric acid free.

MATERIALS.	COMPOSITION.	PRODUCTS.
1 eq. Tartrate Lime = 94	1 *eq. Tartaric Acid* = 66	1 eq. Tartaric Acid.... 66
	1 *eq. Lime* =........ 28	
1 eq. Sulphuric Acid = 40	....	1 eq. Sulphate Lime = 68
134		134

Properties.—Tartaric acid crystallizes in elongated, colourless,

Fig. 67.

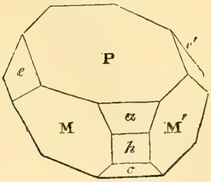
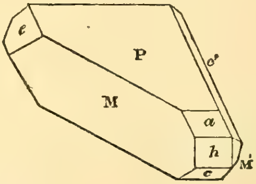


Fig. 68.



Crystals of Tartaric Acid.

Fig. 67. The crystal as usually modified.

Fig. 68. The same modified form, with the planes irregularly disposed, as they appear in most of the crystals.

(The corresponding planes in both figures are marked with the same letters).

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[k] The Edinburgh College employs the same quantity (Ovii. and f℥xvii.) of diluted Sulphuric Acid as is used by the London College; but, as its strength is weaker, the quantity ought to have been greater. The "Edinburgh College should have directed more than ten pints of diluted Sulphuric Acid, instead of less than eight." (Mr. R. Phillips, *London Medical Gazette*, N. S. vol. ii. 1838-39, p. 689.)

inodorous, very sour, imperfectly transparent prisms, which belong to the oblique prismatic system[m].

They are permanent in the air. When heated they fuse, and undergo chemical changes varying with the degree and continuance of the heat. When they have lost by heat a fourth of their water, they become *tartralic acid*, which has, in its salts, the same composition as tartaric acid, but neutralizes one-fourth less base. It differs from tartaric acid, therefore, as pyrophosphoric acid differs from phosphoric acid. When tartralic acid is further heated it loses as much more water, and becomes *tartrelic acid*, which also has, in its salts, the composition of tartaric acid, but only half the neutralizing power. It corresponds, therefore, to metaphosphoric acid. By a higher degree of heat all the water of this acid is driven off, and we have *anhydrous tartaric acid*, which, however, has lost its acid properties, and is quite insoluble in water[n]. "This is a powerful argument in favour of the view, according to which all acids are compounds of hydrogen" (Liebig). When subjected to distillation, tartaric acid yields carbonic acid, water, and two pyrogenous acids,—one of which is crystalline, and is called *pyrotartaric acid* ($C^5 H^3 O^3$ + Aq.); the other is oily, and is termed *pyruvic acid* ($C^6 H^3 O^5$ + Aq.) Strongly heated in the air it evolves the odour of caramel, and furnishes a carbonaceous mass, which eventually disappears by combustion. Cold water dissolves crystallized tartaric acid: boiling water takes up twice its own weight of the acid. A soft, mucilaginous, flexible mass, forms in a solution of tartaric acid, as well as of emetic tartar, when long kept[o]. Alcohol sparingly dissolves the acid. Heated with either nitric acid or potash it yields oxalic acid. By the action of sulphuric acid on it acetic acid is formed.

Characteristics.—A solution of tartaric acid is very sour, and causes with solutions of caustic, lime, baryta, and strontia, white precipitates *(earthy tartrates)*, soluble in excess of acid. Sal ammoniac dissolves the precipitate *(tartrate of lime)* produced by lime water. With acetate of lead the solution of tartaric acid also forms a white precipitate *(tartrate of lead)* soluble in excess of acid. Dropped into a solution of sulphate of lime it furnishes no precipitate. Heated with a solution of chloride of platinum, tartrate of potash occasions a black precipitate *(metallic platinum)*. If excess of acid be added to a concentrated solution of a potash salt, small granular crystals *(bitartrate of potash)* are deposited. With nitrate of silver, tartrate of potash furnishes a white precipitate *(tartrate of silver)*, which, when heated, does not deflagrate, but becomes brown, froths up, evolves white fumes, and leaves pure silver.

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[m] Brooke, *Annals of Philosophy*, N. S. vol. vi. p. 118.

[n] See Fremy, *Ann. de Chim. et de Phys.* Août, 1838.

[o] This formation is probably owing to the developement in the solution of a vegetable organized being. Keïtzing (*Repertoire de Chimie*, t. iii. p. 278, Paris, 1838) has described and figured the plant which forms in a solution of emetic tartar.

Composition.—The composition of tartaric acid is as follows :—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*
Carbon	4	24	36·36	35·980
Hydrogen	2	2	3·03	3·807
Oxygen	5	40	60·61	60·213
Anhydrous Tartaric Acid	1	66	100·00	100·000

	Atoms.	*Eq.Wt.*	*Per Cent.*
Anhydrous Tartaric Acid	1	66	88
Water	1	9	12
Crystallized Tartaric Acid	1	75	100

Liebig regards the equivalent weight of the acid as double that above assumed; and the acid, therefore, is considered as a bibasic one, inasmuch as, on that hypothesis, it saturates two equivalents of base. Fremy's researches, above referred to, tend to support this view.

Impurity.—The only adulteration practised on this acid is the mixture of its powder with bitartrate of potash. This fraud may be detected by the difficult solubility in water of the bitartrate, and its yielding, on incineration, carbonate of potash (known by the tests hereafter to be described). The tests of the purity of the acid, given by the London and Edinburgh Colleges, are as follows ;—

> "Totally soluble in water. The solution throws down bitartrate of potash from any neutral salt of potash. Whatever is precipitated from this solution by acetate of lead is dissolved in diluted nitric acid."—*Ph. L.*

A precipitate insoluble in nitric acid would indicate the presence of sulphuric acid or a sulphate.

> "When incinerated with the aid of the red oxide of mercury, it leaves no residuum, or a mere trace only."—*Ph. Ed.*

This test is devised to detect any fixed substance, and might be used to recognise the potash, if bitartrate of this alkali had been present.

Physiological Effects.—The effects of tartaric acid, *in small doses* properly diluted, are those of a refrigerant (see p. 193). It reduces febrile heat, diminishes excessive vascular action, allays thirst, checks excessive perspiration, and perhaps also a too copious secretion of bile. It appears to promote the action of the absorbents, to increase the secretion of urine (see p. 201), and to act gently on the bowels. It possesses the tonic properties of the mineral acids (see p. 212) in a very slight degree only, if at all. Its continued use very readily disturbs the digestive process. Some doubt exists as to the effects of *large doses* of the acid. According to Dr. Christison[p] it may be taken in very considerable quantities without injury. Six drachms have been taken in twenty-four hours without inconvenience. Pommer, however, asserts that when it is injected into the veins, it is scarcely less poisonous than oxalic acid (*Ibid.*)

Uses.—Tartaric acid may be used as a cheap substitute for citric acid or lemon juice, in the formation of acidulous refrigerant drinks, for febrile and inflammatory disorders. It is, however, rarely employed for this purpose. Its common medicinal use is in the preparation of effervescing compounds, with the alkaline carbonates, especially with bicarbonate of soda.

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[p] *Treat. on Poisons*, p. 208, 3d ed.

EFFERVESCING TARTRATES.—The following are the relative proportions of tartaric acid and alkaline carbonates for preparing effervescing draughts :—

20 *grs. of the Crystals of Tartaric Acid are saturated by*—

Crystallized Bicarbonate of Potash	27	grains.
Carbonate of Potash of Commerce	22	„
Hydrated Sesquicarbonate of Ammonia	15½	„
Crystallized Carbonate of Soda	38½	„
Sesquicarbonate of Soda of Commerce	22	„

The most commonly used effervescing tartrate is that made with sesquicarbonate of soda (see *Sodæ Sesquicarbonas* and *Sodæ Tartras*).

10. AC'IDUM BENZO'ICUM, *L. E. D.*—BENZOIC ACID.

HISTORY.—This acid was described in 1608 by Blaise de Vigenere ; but it seems to have been known to Alexander Pedemontanus in 1560. The acid obtained by sublimation is frequently denominated *Flowers of Benjamin (Flores Benzoini).*

NATURAL HISTORY.—Benzoic acid is peculiar to the organized kingdom.

It exists ready formed in certain vegetable substances (as the balsams), and is readily produced in some others by the action of exterior agents (as heat, air, acids, and alkalis). "It is formed by the oxidation of hydruret of benzule in the air, and by the decomposition of many compounds of benzule, and of hippuric acid and amygdaline by oxidizing reagents" (Liebig). It is also produced by the action of potash on cinnamon and some other oils (Mulder). It is readily obtained from, and was formerly supposed to exist in, certain animal substances (as the urine of herbivorous animals), which are now known not to contain it, but yield it only by the decomposition of some of their proximate principles. The benzoic acid procured from the urine of horses is not originally contained in that liquid, but is produced by the decomposition of hippuric acid, which is readily converted into benzoic acid. Thus, if the urine of the horse or cow be left to itself for a long time, or evaporated at a boiling temperature, it yields not a trace of hippuric acid, but only benzoic acid.

PREPARATION.—All the British colleges give directions for the preparation of this acid.

The *London College* orders of Benzoin, lb. j. Put the benzoin in a proper vessel placed on sand, and the heat being gradually raised, sublime until nothing more rises; press that which is sublimed, wrapped in bibulous paper, and separate it from the oily part. Afterwards again sublime it.

The directions of the *Edinburgh College* agree with these, except that they order "any convenient quantity" of benzoin to be used, and "a glass-matrass" to be employed in the manufacture.

The process of the *Dublin College* is as follows : — Benzoin, five parts; Lime, fresh burnt; Muriatic Acid, of each, one part; Water, two hundred parts. Triturate the Benzoin with the Lime, then boil the mixture in one hundred parts of Water; suffer the vessel to rest, and pour off the liquor when cold. Boil the remainder in seventy parts of water, and again pour off the cold liquor. Evaporate the mixed liquors to one-half, filter them through paper, and to the liquors, when cold, gradually add the Muriatic Acid. Lastly, having decanted off the supernatant fluid, dry with a gentle heat the residual powder, previously washed with a small quantity of cold water; pass it into a proper vessel, and with a slow fire sublime the benzoic acid.

The process of the *London* and *Edinburgh Colleges* is the simplest, and, I believe, the most economical. The following is the method practised at Apothecaries' Hall, London:—"The better kind of benzoin is most economically employed: it may be put into an iron pot, set in brickwork over a proper fire-place: the sublimate is most conveniently received into a large wooden box, lined with paper, communicating with a conical iron or tin-plate neck with the subliming pot. The first product may be sublimed a second time in the same apparatus; and, by conducting the process rather rapidly, the acid condenses in beautiful prismatic crystals, somewhat elastic. If slowly sublimed it is more scaly. By this process of sublimation, good benzoin yields 10 to 12 per cent. of acid contaminated by empyreumatic oil; and which, when pressed between folds of blotting-paper, and again sublimed, is reduced to the proportion of 8 or 9 per cent. of the purified acid[q]." The simplest method of procuring it is by putting coarsely-powdered benzoin into an earthen pot, over which is placed a cone of thick brown paper or pasteboard, and applying a moderate heat: the acid sublimes into the cone, and there condenses. Some employ, as a substitute for the cone, *a house*, as it is termed, made of pasteboard and laths, and lined with loose sheets of blotting-paper, which are renewed every time of use. The oil produced in sublimation is, for the most part, formed during the process.

Mohr[r] gives the following directions for preparing it:—Benzoin, in the form of a coarse powder, either alone or mixed with an equal weight of sand, is spread upon the bottom of a round vessel, of cast or plate iron, eight or nine inches in diameter, with the sides about two inches high. A sheet of dry bibulous paper is stretched tightly over the opening, and fastened to the sides of the vessel by a little paste. A hat made of thick paper, and of the common form of a man's hat, is made to cover the whole, and tightly tied to the sides of the vessel by a strong string. The vessel is now placed upon sand spread upon an iron plate, below which a fire is kept for three or four hours. The vapours of the sublimed benzoic acid pass readily through the pores of the bibulous paper, and are deposited in crystals upon the hat; the crystals are prevented from falling back into the iron vessel by the paper which closes its opening[s]. Moreover, the paper absorbs the oil which sublimes with the acid.

Scheele's process, adopted by the *Dublin College*, is, I believe, seldom followed. By boiling benzoin and lime with water, a soluble *benzoate of lime* is formed. Muriatic acid is then added to the concentrated solution, by which *benzoic acid* is precipitated, while *chloride of calcium* (in solution) and *water* are formed. The precipitated benzoic acid is then sublimed. The acid, obtained by this process, is said to be whiter and purer (being free of empyreumatic oil) than that procured by sublimation only. Carbonate of soda is sometimes substituted for lime in the above process, by which a soluble benzoate of soda is obtained.

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[q] Brande, *Manual of Chemistry*, p. 1153, 5th edit.

[r] *Ann. der Pharm.* xix. p. 178; also, *Pharmaceutisches Central-Blatt für* 1839, p. 233; and Liebig, in Turner's *Elements of Chemistry*, 7th edit. p. 781.

[s] For some practical remarks on the preparation of this acid, see Euler and Herberger, in *Pharmaceutisches Central-Blatt für* 1840, p. 166.

PROPERTIES.—As met with in the shops benzoic acid occurs in the form of soft, light, feathery white crystals, or scales, which are flexible, transparent, and of a mother-of-pearl lustre, having a sour, warm taste, but no odour when pure. It readily fuses and volatilizes, its vapour being exceedingly irritating to the air-passages. It is combustible, burning with a bright yellow flame. It is very soluble in about two hundred parts of cold water, dissolves in about twenty-five parts of water, and is very soluble in alcohol.

Characteristics.—Benzoic acid is readily distinguished from other acids by its light and feathery crystals, its fusibility, volatility, odour of its vapour, and by the characters of its soluble salts. Thus the benzoate of ammonia produces, with the sesquisalts of iron, a pale red precipitate (*benzoate of iron*), and with the nitrate of silver, acetate of lead, nitrate of mercury, and supernitrate of bismuth, white precipitates (*benzoates* of the respective metals).

COMPOSITION.—The following is the composition of this acid:—

Ultimate constituents.

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Dumas.*
Carbon	14	84	74·3	74·7
Hydrogen	5	5	4·4	4·3
Oxygen	3	24	21·3	21·0
Anhydrous Benzoic Acid	1	113	100·0	100·0

Hypothetical constitution.

	Atoms.	*Eq.Wt.*
Benzule	1	105
Oxygen	1	8
Anhydrous Benzoic Acid	1	113

The crystallized acid contains one equivalent or 9 parts of water $(\overline{Bz} + aq.) = 122$.

Benzule or *Benzoyle* is the hypothetical radicle of benzoic acid. It consists of $C^{14} H^5 O^2$. Laurent discovered a crystallizable substance, which he termed *benzule*, but which Liebig calls *benzile*. It has the composition of the hypothetical radical benzule. Oil of bitter almonds is the *hydruret of benzule* ($C^{14} H^6 O^2$).

PURITY.—Good benzoic acid has the following properties:—It is colourless, and is sublimed entirely by heat (*Edinb. Pharm.*) When cautiously heated it totally evaporates with a peculiar odour. It is sparingly soluble in water, but plentifully in rectified spirit. It is entirely dissolved by solution of potash or lime-water, and is precipitated from its solution by hydrochloric acid (*Pharm. Lond.*)

PHYSIOLOGICAL EFFECTS.—The local action of benzoic acid is that of an acrid. When swallowed it occasions a sensation of heat and acridity in the back part of the mouth and throat, and heat at the stomach. The inhalation of its vapour causes violent coughing.

When taken into the stomach benzoic acid becomes absorbed, and operates on the general system as a stimulant, whose influence is, however, principally directed to the mucous surfaces, especially the aërian membrane. According to Dr. Alexander Ure[t], hippuric acid

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[t] Proceedings of the Royal Medical and Chirurgical Society, in the *London Medical Gazette*, N.S. vol. 1840-41, p. 735; also, *Pharmaceutical Transactions*, No. 1. p. 24. Lond. 1841.

($C^{18} NH^{8} O_5 + Aq.$) is found in the urine two hours after taking benzoic acid, while not a trace of uric acid is recognizable. This effect does not always take place. I have found it produced readily in a rheumatic subject.

Uses.—Benzoic acid is a constituent of the *Tinctura Camphoræ Composita;* but otherwise is but little employed in medicine. It is sometimes employed in chronic bronchial affections. I have repeatedly tried it, but have seldom seen benefit result from its use. I have more frequently seen it augment than relieve the cough. Dr. A. Ure has suggested the employment of benzoic acid, or a benzoate, in the gouty diathesis, to prevent the formation of the tophaceous concretions commonly called *chalk stones,* and which consist of urate of soda.—Dose, grs. v. to ℈j.

11. CREASO'TON, *L.*—CREASOTE.

Creazotum, *E.*

(An Oxy-hydro-carburet; prepared from pyroxilic oil, *L.*)

History.—This substance was discovered a few years since by Reichenbach, who termed it *Creasote* (from κρέας, *flesh,* and σώζω, *I preserve*), or the *flesh-preserver,* on account of its antiseptic property. Its name is sometimes written *Creosote,* or *Kreosote.*

Natural History.—It is an artificial product; and is obtained by the destructive distillation of organic substances. It is found in pyroligneous acid, in tar, in Dippel's oil, in wood smoke, and empyreumatic waters.

Preparation.—The preparation of creasote is a very troublesome and tedious process. The following concise abstract of it is taken from Turner's *Elements of Chemistry* (5th ed. p. 872). Those portions of the oil (called in the Pharmacopœia *pyroxilic oil*) distilled from wood-tar, which are heavier than water, are first freed from adhering acetic acid by carbonate of potash, and, after separation from the acetate, are distilled. A little phosphoric acid is mixed with the product to neutralize ammonia, and another distillation resorted to. It is next mixed with a strong solution of potash, which combines with creasote, allows any eupion which may be present to collect on its surface, and by digestion decomposes other organic matter: the alkaline solution is then neutralized by sulphuric acid, and the oil which separates is collected and distilled. For the complete purification of the *creasote,* this treatment with potash, followed by neutralization and distillation, requires to be frequently repeated[u]. The oil from which creasote is prepared, is that obtained by the distillation of wood-tar, and is either imported from Stockholm, Archangel, and America, or is made in the manufacture of pyroligneous acid.

Properties.—Pure creasote is colourless and transparent; and has a high refractive power, and an oleaginous consistence. Its odour is that of smoked meat, its taste burning and caustic, its sp. gr. 1·037 at 68° F. It boils at 397° F.; and is fluid at —16·6° F. It is combustible, burning with a sooty flame. It absorbs chlorine, and is resinified by it. Nitric acid is decomposed by it, with the evolution of nitrous fumes. Sulphuric acid in small quantity reddens, and in large quantity blackens it. Potassium decomposes it, with the evolution of gas (hydrogen?) and the formation of potash, which combines with some inspissated creasote. It is soluble in alcohol, ether, sulphuret of carbon, eupion, naphtha, acetic acid, and acetic ether. It dissolves resins, various colouring matters (as of cochineal, saffron, and madder), and some salts (as the acetate of potash). It has very little action on caoutchouc; and does not possess any acid or alkaline re-action on test paper. Mixed with water, it forms two combinations: one is a solution of 1·25 parts of creasote in 100 of water; the other, on the contrary, is a solution of 10 parts of water in 100 of creasote.

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[u] For further details I must refer to Dumas' *Traité de Chimie;* the *Ann. de Chim. et Physiq.* t. 57, 1834; and Cozzi, in the *Journal de Pharmacie,* t. xxviii. p. 629.

It coagulates the albumen of eggs and of the blood. Concentrated albuminous liquids are immediately coagulated by it; diluted ones, gradually. Fibrin is not altered by it. It is powerfully antiseptic with respect to meat and fish. Tar, smoke, and crude pyroligneous acid, owe part, if not the whole, of their antiseptic properties to it. According to Mr. J. R. Cormack[v], the only essential part of the mummifying process practised by the ancient Egyptians was the application of such a heat as would first dry up the body, and then decompose the tarry matters which had been previously introduced, and thus generate creasote.

A patent has been taken out by Mr. Flockton, for the preservation of wood, &c. by creasote. The liquid actually used under this patent is the impure oily liquor obtained by distillation from tar, and in which old iron has been digested, so that it is a mixture of various volatile oils and acetate of iron.

Characteristics.—The odour of creasote is its most characteristic property. To this must be added its combustibility, its oleaginous appearance, its complete solubility in acetic acid and caustic potash, and its action on albumen before mentioned.

IMPURITY.—Creasote, when pure, is perfectly colourless; but that met with in commerce has frequently a more or less brownish tinge. Rectified oil of tar, capnomor, and a substance like almond oil, are substances which have been mixed with it[w]. These impurities are readily detected by mixing separate portions of the suspected liquid with acetic acid and caustic potash: pure creasote is completely soluble in these fluids; not so the adulterated. Capnomor is similar to creasote in many of its physical and chemical properties, and is frequently associated with the creasote of the shops.

COMPOSITION.—Ettling[x] analyzed creasote which was supposed to contain three per cent. of water. Making allowance for this impurity, its composition, as determined by this chemist, is nearly as follows:—

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[v] *Treatise on Creosote.* Edinburgh, 1836.
[w] Cormack, *op. cit.*
[x] *Ann. de Chimie*, liii. p. 333.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Carbon	14	84	77·42
Hydrogen	9	9	8·12
Oxygen	2	16	14·46
Creasote	1	109	100·00

At present, however, the equivalent of creasote must be considered as uncertain, since no definite compound of this substance has been analyzed, by which the combining proportion could be ascertained.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Plants moistened with creasote water fade and die[y]. The injurious effects of smoke on vegetation are probably to be referred principally to the creasote which it contains.

β. On Animals generally.—Insects (as flies), spiders, and small fishes, die in two minutes after their immersion in water containing a few drops of creasote suspended in it. According to Mr. Cormack, the effects of creasote on dogs are remarkably similar to those of hydrocyanic acid, and are much less apparent when this substance is injected into the carotid arteries than into the veins. When thrown into the latter it suddenly stops the heart's action, and causes hurried respiration, one or two convulsive fits, shrill cries, and death. Injected into the carotid artery it produces coma. Introduced into the stomach it gives rise to dimness and fixation of the eyes, vertigo, and coma: when given in large quantities it also affects the heart[z]. Corneliani[a] and Miguet have observed inflammation of the gastro-intestinal mucous membrane of dogs poisoned by creasote, but which survived some time after its administration.

γ. On Man.—Creasote operates locally as an irritant and caustic. Applied to the skin it causes heat, redness, and the destruction of the cuticle, which comes away in the form of furfuraceous scales. On the tongue it produces a painful sensation. Dropped into the eye it occasions acute pain. Placed in contact with a suppurating surface it whitens the part, like nitrate of silver. Swallowed in large doses it causes vomiting and purging. The caustic effect of creasote depends on its union with albumen.

Unless largely diluted, it occasions, when swallowed, heat in the pharynx, œsophagus, and stomach. Small doses, as one or two minims, produce in most individuals no other unpleasant effect than that just mentioned. Larger doses give rise to nausea, vomiting, vertigo, headache, and heat of head. Dr. Elliotson[b] knew a lady who increased the dose of creasote to forty drops before it disagreed: the addition of a single drop beyond this produced extreme giddiness, insensibility, and vomiting, followed by headache for several days. When given in moderate doses it does not affect the bowels; so that, as Dr. Elliotson has observed, "aperients are as requisite as if it was not taken." When, however, the dose has been considerably augmented, diarrhœa, or even dysentery, has been produced[c]. The influence of creasote on the urinary organs is sometimes very marked. Dr. Macleod[d] was, I believe, the first who noticed that the urine acquired a blackish colour by the use of it. A similar effect is referred to by Dr. Elliotson. In some cases creasote is recognised, by its odour, in the urine, showing that it has been absorbed. Occasionally it increases the quantity of this secretion, but in diabetes it sometimes has an opposite effect. In some instances it has caused micturition and strangury, so that in its influence over the urinary organs it bears some resemblance to turpentine. Some other effects which have been ascribed to it require further evidence to establish them. In the dose of two drachms creasote proved fatal in thirty-six hours. It caused acute pain[e].

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[y] Miguet, *Recherches sur la Créasote*, 1834.

[z] Cormack, *op. cit.* p. 66, et seq.

[a] *Jour. Chem. Méd.* t. ii. ser. 10; and *Brit. & For. Med. Rev.* vol. i. p. 265.

[b] *Medico-Chirur. Trans.* vol. xix.

Uses.—Various substances, some known to contain creasote, others supposed to do so, have long been used in medicine, in the same diseases in which creasote itself is now employed; and, in consequence, it has been imagined that they owe part of whatever efficacy they really possess to this substance. These remarks apply to Tar[f], Soot[g], Crude Pyroligneous Acid, *Aqua Binelli*[h], the Empyreumatic Water of Runge and Hanke, Pyrothonide[i], and Animal or Dippel's Oil. To this list should be added, according to Mr. Cormack (*op. cit.*), Mummy.

As an *internal* remedy, creasote has been principally celebrated, in this country, as a remedy possessing extraordinary powers of arresting vomiting. It has, however, been greatly overrated. It is decidedly injurious in inflammatory conditions and structural disease of the stomach, and frequently fails in allaying the sickness dependent on organic diseases, as of the heart and kidneys. It is most successful in hysterical cases, and sometimes succeeds in pregnancy. Creasote was first employed to relieve vomiting by Dr. Elliotson[j], to whose paper, as well as to that of Mr. Taylor, apothecary of the North London Hospital[k], I must refer for cases illustrative of extraordinary success with it. It is regarded by Dr. Macleod[l] as of doubtful efficacy; and has completely failed in the hands of Dr. Paris[m]. Dr. Burne[n], however, found it efficacious in gastro-enteritic irritation. I have found it much more frequently fail than succeed in alleviating irritable stomach. It sometimes relieves the chronic vomiting connected with granular disease of the kidneys when other means fail[o].

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[c] Cormack, *op. cit.* p. 93.

[d] *Lond. Med. Gaz.* vol. xvi. p. 599; and vol. xvii. p. 653.

[e] See *The Times* of June 17, 1839. I presume the mental faculties were unaffected.

[f] Tar will be described hereafter.

[g] Wood Soot (*Fuligo Ligni*) was formerly contained in the list of the materia medica of the British Pharmacopœias. It is still in use on the continent, and statements of its efficacy are occasionally met with in the periodicals. It is a mixture of distilled products from the imperfectly burnt wood and of ashes, or other fixed matters, carried up the chimney by the current of air. It consists of a pyrogenous or empyreumatic resin called *pyretin*, combined with *acetic acid*, which also saturates the bases (*potash, lime,* and *magnesia*) of the ashes which are carried up the chimney. Besides these, there are small quantities of *sesquioxide of iron*, *silica*, and *carbon*. *Acetate of ammonia, chloride of calcium,* and *sulphate of lime*, are also contained in soot. Moreover, there is *extractive matter*, part of which is insoluble in alcohol. Lastly, to these constituents must be added *creasote*. Braconnot (*Ann. Chim. et Phys.* t. xxxi. p. 37) mentions a bitter principle, which he calls *asbolin*, (from ἀσβόλη, soot) in soot; but Berzelius (*Traité de Chemie*, t. vi. p. 725) considers it to be a mixture of different matters with the acid pyretine. The matters insoluble in water constitute about 0·44 of soot. Formerly soot was esteemed tonic, antispasmodic, and emmenagogue. It is now principally employed, as an external remedy, chiefly in ringworm and other analogous eruptions, and obstinate ulcers. It is employed in the form of *decoction* (prepared by boiling two handfuls of soot in a pint of water for half an hour) and of *ointment* (composed of a drachm of soot to an ounce of lard). The decoction has been used as an injection in chronic cystitis, (*Lond. Med. Gaz.* 1839-40, vol. i. p. 864). The *Tincture of Soot*, formerly in the London Pharmacopœia, consists of Wood Soot, ℥ij.; Asafœtida, ℥j.; and Proof Spirit, f℥xxxij. It is sometimes called *Soot Drops* or *Hysteric Mixture*, and is prescribed in doses of one or two tea-spoonfuls in hysteria.

[h] Aqua Binelli, or *Aqua arterialis balsamica Doctoris Binelli*, a once-celebrated styptic, discovered by a physician (Dr. Binelli) of Turin, in 1797 (Dierbach, *Neuesten Entdeck. in d. Mat. Med.* 2te Ausg. 1837. See also Dr. J. Davy, *Edinb. Med. and Surg. Journ.* July, 1833).

[i] Pyrothonide (from πῦρ, *fire;* and ὀθόνη, *linen*), or *liquor pyro-oleosus e linteo paratus*, is a very popular remedy for tooth-ache and skin diseases. It is sometimes prepared by distilling rags, and is then called *rag oil;* but the common mode of procuring it is to burn a cone of paper on a plate or other cold body; it is then termed *paper oil.* It has been analyzed by Herberger (Buchner, *Repertorium*, Bd. 32, S. 347). For further particulars concerning it, consult Merat and De Lens, *Dict. Mat. Méd.*; Dierbach, *op. cit.*; Schwartze, *Pharm. Tabell.* 2te Aus.; L. Richter, *Ausführl. Arzneim.* Supplem. Bd.

In gastrodynia or flatulence it occasionally succeeds, but is admissible in those cases only in which local stimulants are usually found beneficial. Where both hydrocyanic acid and creasote have been separately tried without success, Dr. Elliotson advises their union.

Creasote has been tried in a few cases of diabetes. In some it diminished both the quantity and saccharine quality of the urine[p]. I have tried it at the London Hospital, but without obtaining benefit from its use.

In neuralgia, hysteria, and pulmonary diseases, it has also been used with occasional advantage: but a more extended experience is required to establish its efficacy in these cases.

As an *external* agent creasote may frequently be employed with great advantage. It has been successfully applied to relieve toothache. After carefully cleaning out the cavity of the tooth, a drop of creasote, or an *alcoholic solution* of this principle, may be introduced by means of a camel's hair pencil, and the cavity filled with cotton soaked in this liquid. As a local application to chronic skin diseases (particularly the different forms of porrigo, impetigo, eczema) it is of considerable value. Where a caustic application is required, it may be applied undiluted; but for other purposes it is used either in the form of ointment, or dissolved in water as a wash. Creasote may be beneficially used as an application to foul and indolent ulcers. It serves the double purpose of stimulating the living surface (and thereby of changing the quality of actions going on in the part), and also of preventing the putrefaction of the secreted matters. It is sometimes applied pure, but more commonly diluted with water. Lupus is said to have healed under the employment of an ointment of creasote[q]. In hemorrhages creasote acts as a most efficient styptic, partly in consequence of its power of coagulating albuminous liquids, and thereby of causing the formation of a clot, and partly by causing contraction of the bleeding vessels. *Creasote water* (prepared by mixing one part of creasote with eighty parts of water) may be applied either to bleeding wounds and leech-bites, or introduced into the vagina in uterine hemorrhage, by means of pledgets of lint soaked in it. There are many other purposes for which creasote has been applied as a local agent, but which I think it sufficient merely to name, referring the reader to the various papers and works before quoted for further information. It has been employed to check caries, to restrain excessive suppuration, and to repress fungous granulations in burns and scalds; to act as a counter-irritant in chronic ophthalmia, in which disease it is sometimes dropped into the eye on the same principle that nitrate of silver and other local stimulants are used; and to remove condylomatous and other excrescences. The inhalation of creasote vapour is occasionally useful in relieving excessive bronchial secretion. Dr. Elliotson cured two cases of chronic glanders in the human subject, by injecting an aqueous solution of creasote up the affected nostril[r].

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[j] *Medico-Chirurg. Trans.* vol. xix.

[k] *Lancet*, August 15, 1835.

[l] *London Medical Gazette*, vol. xvi. p. 598, and vol. xvii. p. 653.

[m] *Appendix* to the 8th edit of the *Pharmacologia*, 1838.

[n] *London Medical Gazette*, August 18th, 1838.

[o] See Christison, *On Granular Degeneration of the Kidnies.* Edinb. 1839.

[p] Dr. Elliotson, *Med.-Chirurg. Trans.* and Professor Berndt, *Lancet*, July 18, 1835.

[q] Mr. Browne, in the *London Medical Gazette*, for April 7, 1838.

ADMINISTRATION.—Creasote may be given, at the commencement of its use, in doses of one or two drops diffused through an ounce of some aromatic water by the aid of mucilage: the dose should be gradually increased. As before mentioned, in one case forty drops were given with impunity: in another instance, ninety drops were administered in less than half a day without any bad symptom[s].

As a caustic, undiluted creasote is sometimes applied by means of a camel's hair pencil.

Lotions, gargles, or injections of creasote, are prepared by dissolving from two to six drops (according to the circumstances of each case) in an ounce of water. A solution of this kind is sometimes mixed with poultices.

The inhalation of creasote vapour may be effected by diffusing a few drops of creasote through water or a mucilaginous liquid, and breathing through this, by means of the ordinary inhaling bottle (see p. 152).

ANTIDOTES.—In a case of poisoning by creasote, the depression of the vital powers is to be counteracted by ammonia and other stimulants. Mr. Cormack suggests the use of chlorine, but the value of this agent has not been determined by actual experiment. Oleaginous and mucilaginous drinks are recommended by Corneliani, for the purpose of preventing the local action of creasote on the mucous lining of the stomach and intestines. Vinegar does not diminish, but, according to Corneliani, increases its activity. Mr. Cormack says albumen augments [?] its poisonous operation. Bleeding is suggested by this writer, in order to relieve the distension, and thereby to excite the contractions, of the heart. Artificial respiration should on no account be omitted. Any inflammatory symptoms which may subsequently appear are of course to be treated by the usual antiphlogistic measures.

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[r] See also *Lancet*, vol. ii. for 1834-5, p. 398.
[s] Mr. Taylor, *Lancet*, August 15, 1835.

1. **MISTURA CREASOTI.** *Mistura Creazotæ*, E. ("Take of Creazote and Acetic Acid, of each, ♏xvj.; Compound Spirit of Juniper, and Syrup, of each, f℥j.; Water, f℥xiv.; mix the creazote with the acid, then gradually [add] the water, and lastly the syrup and spirit). Dose f℥j. to f℥ij. or more.

2. **UNGUENTUM CREASOTI**, L. *Unguentum Creazoti*, E. (Creasote, fʒss.; Lard, ℥j. rub and mix them, *L.* —Axunge, ℥iij.; Creazote, ʒj. Melt the axunge, add the creazote, stir them briskly, and continue to do so as the mixture concretes on cooling, *E.*)—It is used principally in skin diseases, as ring-worm. The quantity of creasote may be augmented or lessened according to circumstances.

12. PETRO'LEUM, *L. E. D.*—PETROLEUM OR ROCK OIL.

Petroleum (Barbadense), *L.*
(Bitumen Petroleum. Petroleum Barbadense, *D.*)

History.—Herodotus[t] mentions the petroleum springs of Zacynthus (now called Zante) more than 400 years before Christ. Plutarch, in his Life of Alexander, speaks of a lake of naphtha at Ecbatana (now Hamedan), in Media. The substance known to mineralogists as petroleum is the *black naphtha* (νάφθα μέλαινα) of Dioscorides (lib. i.), the *bitumen liquidum* of Pliny (lib. xxxv.)

Natural History.—There are two varieties of liquid bitumen or mineral oil: one is transparent and nearly colourless, or only slightly yellow, and when burnt leaves no residuum; the other is thick, of a reddish brown colour or blackish, and leaves, after combustion, a black coal. The first is called *naphtha* (a Chaldæan word); the second *petroleum* (from *petra*, a rock; and *oleum*, oil) or *rock oil*, because it is frequently found exuding in the form of an oily liquid from rocks. Both kinds are supposed to be produced by the decomposition of organic (vegetable) matter, for they are always found in Neptunian rocks, and they appear sometimes to be one of the products of the decomposition of coal[u]. From the investigation of Drs. Christison and Gregory[w], it appears probable that some varieties of petroleum, as that of Rangoon, are products of destructive distillation, since they contain paraffine and eupion, substances obtained from organic bodies by heat.

Petroleum is found in this country at Ormskirk in Lancashire, at Colebrook Dale, and at St. Catherine's Well, near Edinburgh. In France it is produced at the village of Gabian in Languedoc, and hence it was termed *Oleum Gabianum.* It is also found in various other parts of Europe, especially in Italy. In the United States of America it is met with in various places: that from the shore of Seneka Lake in New York is called *Seneka oil.* Several of the West India Islands, especially Barbadoes and Trinidad, yield it. The Barbadoes petroleum (*Petroleum Barbadense,* L. D.; *Pisselæum Indicum,* Dale) is commonly termed *Barbadoes Tar,* or *Barbadoes Naphtha.* Mr. Hughes[x] speaks of two kinds of it; one of a dirty black, inclining to a green, issuing from some hills in St. Andrew's and St. Joseph's parishes; and one of a blacker colour, in St. Joseph's parish. That imported by Mr. Clarke professes to be the produce of the springs on Mount Hall estate, in Barbadoes. In various localities of Asia, petroleum is met with in great abundance.

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[t] *Melpomene*, cxcv.
[u] Berzelius, *Traité de Chim.* t. 6me.
[w] *Trans. of the Roy. Soc. Edinb.* vol. xiii. p. 1.

EXTRACTION.—Mr. Hughes says that the mode of procuring the green tar of Barbadoes is to dig a hole or trench in, or very near, the place where it oozes out of the earth. This by degrees becomes filled with water, having a thick film or cream of this liquid bitumen swimming upon the surface; from whence it is skimmed off, and preserved in earthen jars or other vessels. The most convenient season for gathering it is in the months of January, February, and March.

PROPERTIES.—Barbadoes petroleum, at ordinary temperatures, has the consistence of treacle: its colour is reddish brown or blackish; its odour and taste are bituminous. It floats on water: is combustible, yielding a thick black smoke, and leaving a carbonaceous residuum. It is insoluble in water.

COMPOSITION.—The ultimate constituents of Barbadoes petroleum are *carbon* and *hydrogen,* with small quantities of *oxygen* and *nitrogen.* The latter probably are accidental.

By distillation, five parts by measure yield rather more than four parts of *a yellow oily fluid,* somewhat similar in appearance to the liquid carbo-hydrogen obtained in the manufacture of oil-gas, but dissimilar to naphtha. The residuum in the retort is a substance analogous to *asphaltum.* It yields by destructive distillation traces of ammonia. Some kinds of petroleum contain paraffine and eupion.

PHYSIOLOGICAL EFFECTS.—Petroleum possesses stimulating properties, which are principally observed in its effects on the organs of secretion (the skin, the kidneys, and the mucous membranes), the activity of which it promotes: hence it has been called sudorific, diuretic, expectorant, &c. It becomes absorbed, and in this way probably acts topically on the secreting organs; for Mr. Hughes observes, that when a horse "that has been dosed with it begins to be warm upon his journey, the rider will smell the tar strongly." It is said to be an excitant to the lymphatic vessels and glands.

USES.—As an internal remedy it is employed in chronic pulmonary affections (as winter coughs, old asthmas, &c.), in obstinate skin diseases (as lepra, psoriasis, and impetigo), and against tape-worm. Mr. Hughes says it is used in paralytic and nervous disorders.

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[x] *The Natural History of Barbadoes,* p. 50. Lond. 1750.

As an external agent it is applied to obstinate ulcers, as lupus and cutaneous diseases, and is employed as a stimulating liniment in chronic rheumatism, paralysis, and chilblains.

Administration.—The dose of Barbadoes petroleum is a small tea-spoonful given in any convenient vehicle (as some aromatic water, tea, or spirit). The quantity should be gradually increased. An ounce has been taken in the day without any inconvenience.

13. SUC′CINUM, *L. D.*—AMBER.

History.—Amber was known to Thales of Miletus, 600 years before Christ. He was the first who noticed that, when rubbed, it acquired the power of attracting light bodies. Hence arose the term electricity, from ηλέκτρον, *amber*. Theophrastus [y] also mentions this property.

Natural History.—Amber is found in different parts of the world. The principal portion of that met with in commerce comes from the southern coasts of the Baltic, in Prussia, and is cast on the shore between Königsberg and Memel. It is supposed to be disengaged, by the action of the sea, from beds of lignite.

The vegetable origin of amber is shewn by various facts. It is usually associated with substances (bituminous wood, coal, &c.) known to be derived from plants. Externally we observe on it various impressions of the branches and bark of trees; and inclosed in it are insects and parts of plants (as the wood, leaves, flowers, and fruit). According to Sir David Brewster [z], its optical properties are those of an indurated vegetable juice. From these circumstances, as well as from its chemical composition, amber is supposed to have been a resinous exudation from some tree. Now, as the wood, leaves, blossoms, and fruit of some coniferous plant are found in amber, this plant has been supposed to be the amber tree: and a microscopic examination of the wood leads to the conclusion that the amber tree is a species, though probably an extinct one, of the genus Pinus, closely allied to P. balsamea [a]. On chemical grounds, however, Liebig [b] suggests that it is a product of wax, or of some other substance allied to the fats or fixed oils; since succinic acid is formed by the oxidation of stearic and margaric acids [c].

Properties.—It occurs in irregular shaped pieces, usually flat and somewhat rounded at the sides. Its colour is yellowish white (*succinum album*), yellow (*succinum citrinum*), or reddish (*succinum rubrum*). It is usually translucent, sometimes opaque or transparent: it is tasteless and odourless. Its sp. gr. is about 1·07. It is brittle, yields readily to the knife, has a conchoidal vitreous or resinous fracture, and becomes negatively electrical by friction: it contains various insects which, apparently, must have become entangled in it while it was soft and viscid. (For an account of these, consult Mr. Hope's paper before quoted; also Burmeister's *Manual of Entomology*, p. 574).

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[y] *De Lapidibus.*

[z] *Edinburgh Philosophical Journal*, vol. ii.

[a] Hope, *On Succinic Insects*, in *Trans. Entom. Soc.*, vols. i. and ii. See also Sendelius, *Historia Succinorum.* Lips. 1742.

[b] Turner's *Elements of Chemistry*, 7th edit. p. 1050.

[c] For further details respecting the Natural History of Amber, consult John's *Naturgeschichte d. Suciens*, Coln. 1816; and Graftenhauer's *Histoire Naturelle, chimique, et technique, du Succin.* Paris, 1824.

Heated in the air, amber fuses at about 550° F., then inflames, and burns with a yellow flame, emitting a peculiar odour, and leaving behind a light shiny black coal. It cannot be fused without undergoing some chemical change. It evolves water, volatile oil, and succinic acid: the residual mass is termed *colophonium succini.* By destructive distillation in a retort or alembic, amber yields first an acid liquor (which contains succinic and acetic acids), then some succinic acid deposits in the neck of the retort, and an empyreumatic oil (*oleum succini*) comes over, at first thin and yellowish, afterwards brown and thick: towards the end of the operation a yellow light sublimate is observed in the neck of the retort; this is called, by Berzelius, *crystallized pyrétine;* by Vogel, *volatile resin of amber;* by Gmelin, *amber-camphor.* An inflammable gas is evolved during the whole time of the operation.

COMPOSITION.—The *ultimate* constituents of amber are, *Carbon, Hydrogen,* and *Oxygen.* The *proximate* principles are, a *Volatile Oil, two Resins, Succinic Acid,* and a *Bituminous substance.*

Ultimate Constituents.

	Drassier.	*Ure.*
Carbon	80·59	70·68
Hydrogen	7·31	11·62
Oxygen	6·73	7·77
Ashes (silica, lime, and alumina)	3·27	——
Amber	97·90	90·07

Proximate Constituents.

(Berzelius).
Volatile Oil.
Two Resins.
Succinic Acid.
Bitumen.
Amber.

According to Hünefeldt, hydrochloric acid extracts from amber, besides succinic acid, another acid, very similar to *mellitic acid.*

The *volatile oil* has a strong but agreeable odour. The *resins* are soluble in both alcohol and ether: if an alcoholic solution of the two resins be prepared by heat, and then allowed to cool, one of the resins deposits. The *bituminous matter* constitutes the principal part of amber: it is insoluble in alcohol, ether, the oils both volatile and fixed, and alkaline solutions.

Characteristics and Purity.—The resins copal and animi are sometimes substituted for amber. They may be distinguished by the difference in their colour and fracture, and by their not emitting the peculiar odour of amber when thrown upon hot iron[d]. They do not yield succinic acid when submitted to distillation. Copal, during its combustion, is constantly falling in drops; and by this character may be distinguished from amber[e].

PHYSIOLOGICAL EFFECTS.—Amber was formerly celebrated as a stimulant and antispasmodic. It probably possesses little or no medicinal power.

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[d] *United States' Dispensatory.*

[e] Kidd's *Outlines of Mineralogy,* vol. ii. p. 38. Oxford, 1809.

Uses.—It is not employed as a medicine in this country. It was formerly used in chronic catarrhs, amenorrhœa, hysteria, &c., and was given either in the form of powder, in doses of from ten grains to a drachm, or in that of tincture, a formula for which is contained both in the French Codex and Prussian Pharmacopœia.

1. OLEUM SUCCINI, L. D. *Oil of Amber.*—The following are the directions for the preparation of this oil:—

The *London College* orders Amber to be put into an alembic, so that an acid liquor, an oil, and a salt, contaminated with the oil, may distil in a sand-bath, with a heat gradually increased. Afterwards let the oil distil again, and a third time.

The *Dublin College* directs, of Amber reduced to coarse powder, Pure Sand, of each one part. On the application of heat gradually increased, an acid liquor, oil and an acid in the crystallized form, will distil over. The latter should be received on bibulous paper, and exposed to strong pressure to expel the oil, and again sublimed. By filtration through bibulous paper, the oil may be obtained separate from the acid liquor.

The following mode of preparing this oil I have seen practised by an experienced manufacturer:—The amber is distilled in a large iron still or retort, set in brickwork over a proper fire, and connected with an earthen globe, which opens into an old oil jar for a receiver. Three distilled products are obtained: impure succinic acid, called *volatile salt of amber;* an aqueous liquor, termed *volatile spirit of amber,* consisting of water, acetic and succinic acid, and pyrogenous oil; and *volatile oil of amber.* The residue in the retort is a kind of pitch, and is called *English asphalt.* The oil is afterwards rectified by distillation in an iron pot, to which an earthen head is adapted. A very gentle heat suffices for re-distillation.

Scrapings of Copal and the resin Dammar are frequently substituted for amber. They yield no succinic acid, but a volatile oil scarcely distinguishable from genuine oil of amber.

Volatile oil of amber, when fresh drawn, has a pale yellowish colour, which deepens by age, and a strong and remarkable, but agreeable, odour. It is a powerful local irritant. When rubbed on the skin it acts as a rubefacient, and is sometimes employed in liniments in rheumatism and paralysis. Taken internally it operates, like most other empyreumatic oils, on the nervous system, and is used as a stimulant, antispasmodic, and emmenagogue, in hysteria and amenorrhœa. The dose is from ten to fifteen drops. It is a constituent of the *Tinctura Ammoniæ composita* (see p. 305), which is made in imitation of *Eau de Luce*, the history of which has been fully detailed by Beckmann[f].

Artificial Musk *(Moschus artificialis ; Moschus factitius)* is prepared by adding gradually fʒiijss. of concentrated nitric acid to fʒj. of oil of amber, in a large glass tumbler. When the acid is not of sufficient strength, its action must be assisted by heat. The oil is gradually resinified at the expense of the oxygen of the acid, nitrous fumes being evolved. An orange yellow resin, having a peculiar musky odour, is obtained; which is to be well washed with water to remove all traces of acid. Artificial musk is reputed antispasmodic and nervine, and has been employed in hooping-cough and low nervous fevers. A tincture of it *(Tinctura Moschi artificialis)* is prepared by dissolving ʒj. of artificial musk in fʒx. of rectified spirit. The dose is fʒj.

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[f] *History of Inventions and Discoveries*, vol. iv. p. 595, 2d edit. Lond. 1814.

2. **ACIDUM SUCCINICUM**, D. *Succinic Acid* or *the Acid of Amber; Sal Succini.*—This acid is obtained in the distillation of amber. The mode of purifying it has been already stated. It may also be procured by the oxidation of stearic and margaric acids. It crystallizes in colourless white scales or prisms, which are quite volatile. Anhydrous succinic acid is composed of $C^4 H^2 O^3 = 50$. The sublimed acid is composed of $2\,\overline{S} + \text{aq.} = 109$. It is soluble in water; scarcely so in cold, but more so in boiling alcohol. It is almost insoluble in oil of turpentine, by which it is distinguished from benzoic acid. Succinate of ammonia produces, with the salts of the sesquioxide of iron, a brownish red, flaky precipitate *(persuccinate of iron)*, and, with the salts of lead, a white precipitate *(succinate of lead)*. Succinic acid is said to possess stimulant and antispasmodic properties, and to promote perspiration and urine. It was formerly employed in rheumatism, gout, suppressed or repressed eruptions, cramps, &c. It is now never used in medicine. The dose in which it was formerly given was grs. v. to grs. xv.

IV. COMPOUNDS CONTAINING CARBON AND NITROGEN.

1. O'LEUM ANIMA'LE EMPYREUMAT'ICUM. — EMPYREUMATIC ANIMAL OIL.

When animal substances (as bone or hartshorn) are subjected to destructive distillation, a fetid volatile oil is obtained, which is commonly called *Animal* or *Dippel's Oil.* That which is found in commerce is obtained in the manufacture of bone black (see p. 318). It is identical in its nature with the *Oleum Cornu Cervi*, or *Oil of Hartshorn*, formerly used in medicine. As usually met with it is a thick, brown, viscid oil, having a most repulsive odour. By distillation, however, it may be rendered colourless and limpid, but is soon altered by the action of air and light. Its ultimate constituents are, *Carbon*, *Hydrogen*, *Nitrogen*, and *Oxygen.* It contains ammonia, and therefore has an alkaline re-action. Unverdorben alleges that it contains four oily salifiable bases, to which he has given the names of *odorine*, *animine*, *olanine*, and *ammoline*. Reichenbach has obtained *creasote* from it, and ascribes to this principle the supposed virtues of animal oil. Whatever may be its active principle, animal oil is undoubtedly a very powerful agent. In large doses it acts as an energetic poison, operating in two ways, locally as an irritant, remotely as a narcotic[g]. Swallowed in moderate doses, it stimulates the vascular and nervous systems, and is esteemed antispasmodic. It has been employed as a local agent in bruises, gangrene, porrigo, &c. Internally, it has been used to prevent an attack of epilepsy or ague, as a stimulant in low fevers, and as antispasmodic in hysteria and other affections of the nervous system accompanied with convulsive movements. Bremser[h] used *Chabert's oil* (prepared by mixing three parts oil of turpentine with one part Dippel's oil, and distilling three parts) as an anthelmintic in tape-worm. The dose of animal oil is a few drops, cautiously increased.

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[g] Christison, *Treatise on Poisons.*

2. AC′IDUM HYDROCYAN′ICUM DILU′TUM, *L.*—DILUTED HYDROCYANIC OR PRUSSIC ACID.

(Acidum Hydrocyanicum, *E.*—Acidum Prussicum, *D.*)

History.—The substance called *Prussian* or *Berlin blue* (*Cæruleum Borussicum* seu *Berolinense*) was accidentally discovered by Diesbach at the commencement of the 18th century, and various conjectures were soon offered regarding its nature. In 1746, Dr. Brown Langrish published some experiments made with laurel water in order to investigate its effects on animals[i]. In 1752, Macquer announced that Prussian blue was a compound of oxide of iron, and some colouring principle which he could not isolate; and in 1772, Guyton Morveau concluded that this principle was of an acid nature. Scheele, in 1782, removed some of the mystery connected with Prussian blue, by obtaining *hydrous prussic acid* from it. In 1787 Berthollet ascertained this acid to be a compound of carbon, nitrogen, and hydrogen. In 1800 and 1802, Bohn and Schrader discovered it in laurel-water. Borda, Brugnatelli, and Rasori, first employed the acid in medicine, from 1801 to 1806. In 1815, Gay-Lussac obtained the acid in its pure *anhydrous* state, and explained its composition[k].

Synonymes and Etymology.—It has been denominated *Prussic* (*Acidum Borussicum*), *Zootic* (*Acidum Zooticum*), or *Hydrocyanic Acid*: the first name indicates the substance (Prussian blue) from which it was obtained, the second refers to its animal origin, and the third indicates its constituents, hydrogen and cyanogen (so called from *κύανος*, *blue*; and *γεννάω*, *to produce*; because it is one of the constituents of Prussian blue).

Natural History.—Hydrocyanic acid is a product peculiar to the organised kingdom. It may be readily procured from many *vegetables*, more especially those belonging to the sub-orders *Amygdaleæ* and *Pomeæ*: as from Bitter Almonds, Apple-pips, the Kernels of Peaches, Apricots, Cherries, Plums, and Damsons; the Flowers of the Peach, Cherry-laurel, and Bird-cherry; the Bark of the latter, and the Root of the Mountain Ash. It is said to have been also obtained from plants of other families, as from *Rhamnus Frangula* and Ergot of Rye. In some of the vegetables now referred to, hydrocyanic acid does not exist ready formed, but is a product of the process by which it is obtained. This has been fully proved in the case of the bitter almond, and is inferred in other instances.

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[h] *Traité sur les Vers Intestin.* Paris, 1824.

[i] *Physical Experiments upon Brutes.* Lond. 1746.

[k] The chemical history of hydrocyanic acid is fully detailed in Thomson's *System of Inorganic Chemistry*, vol. ii. 7th edition. The medical history of it is contained in Dr. Granville's *Hist. and Pract. Treatise* on this acid, 2d ed. 1820.

This acid is rarely, if ever, found in animals. One of its constituents (cyanogen) has, however, been detected, in combination with iron, (forming Prussian blue) in the urine, the menstrual fluid, and the sweat: and with sulphur and potassium in the saliva. The greenish-blue discharge of some ulcers probably depends on the presence of Prussian blue. In one case I detected the presence of iron in this discharge[1]. During the decomposition of animal matters, cyanogen is frequently generated: as when blood and carbonate of potash are calcined in an iron pot. It has also been stated, that when cheese is exposed to the action of water and the sun, it disengages ammonia, and if treated, in this state, by alcohol, yields traces of hydrocyanic acid.

Preparation.—The processes for procuring this acid are very numerous. I shall only notice the most important of those which yield the dilute acid employed for medicinal purposes.

a. By the action of diluted Sulphuric Acid on Ferrocyanide of Potassium.—This is the process directed by the London and Edinburgh Colleges:—

The *London College* orders of "Ferrocyanide of Potassium, ℥ij.; Sulphuric Acid, ℥iss.; Distilled Water, Oiss. Mix the acid with four fluidounces of the water, and to these, when cooled and put into a glass retort, add the ferrocyanide of potassium, first dissolved in half a pint of water. Pour eight fluidounces of the water into a cooled receiver; then, having adapted the retort, let six fluidounces of acid, distilled with a gentle heat in a sand-bath, pass into this water. Lastly, add six more fluidounces of distilled water, or as much as may be sufficient, that 12·7 grains of nitrate of silver, dissolved in distilled water, may be accurately saturated by 100 grains of this acid."

The *Edinburgh College* orders of "Ferrocyanide of Potassium, ℥iij.; Sulphuric Acid, f℥vj.; Water, f℥xvj. Dissolve the salt in eleven fluidounces of the water, and put the solution into a matrass: add the acid, previously diluted with five fluidounces of the water, and allowed to cool: connect the matrass with a proper refrigeratory: distil with a gentle heat, by means of a sand bath or naked gas flame, till fourteen fluidounces pass over, or till the residuum begins to froth up. Dilute the product with distilled water till it measures sixteen fluidounces."

On the large scale, the distillation is conducted in a stoneware still, with a worm refrigerator of the same material.

If it be performed in a [tubulated] retort, as directed in the London Pharmacopœia, an adopter should be employed. When small quantities are to be operated on, we may conveniently employ two Florence flasks (one as the receiver, the other as the distilling vessel), connected by a glass tube curved twice at right angles. The receiver should be kept very cool, ice or snow being used if it can be procured: and the heat employed in distilling should be very moderate. The distilled liquor frequently contains a little sulphuric acid, and, by standing, deposits a small portion of Prussian blue. A second distillation, cautiously conducted, will often separate the sulphuric acid; but I have seen Prussian blue formed after the hydrocyanic acid has been carefully distilled three times.

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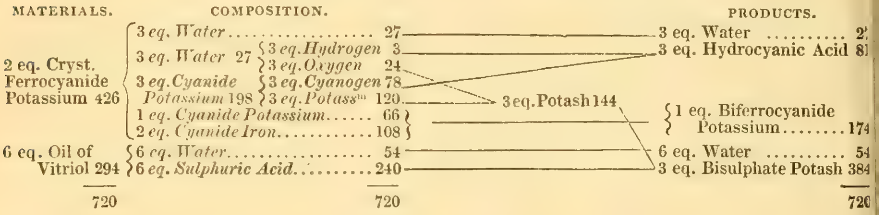
[1] Is the formation of cyanogen dependent on the oxidation of gelatine? Persoy states, that when gelatine is submitted to an oxidizing agent it is susceptible of being transformed into hydrocyanic acid, ammonia, and carbonic acid, and a small quantity of one of the fat, volatile, and odoriferous acids, the existence of which was established by Chevreul (*Brit. and For. Med. Rev.* vol. xii. p. 532).

The theory of the process, founded on the experiments of Mr. Everitt[m], is as follows:—Six equivalents or 294 parts of oil of vitriol ($SO^3 +$ aq.) react on two equivalents or 426 parts of crystallized ferrocyanide of potassium (composed of four equivalents cyanide of potassium, two of cyanide of iron, and six of water), and produce three equivalents or 384 parts of the bisulphate of potash, three equivalents or 81 parts of hydrocyanic acid, one equivalent or 174 parts of a new salt (which I shall term the *biferrocyanide of potassium*), and nine equivalents or 81 parts of water. The bisulphate and the new salt remain in the retort, while the hydrocyanic acid with some water distil over. In the London Pharmacopœia an additional quantity of water is employed to assist the condensation of the acid.


MATERIALS.
COMPOSITION.
PRODUCTS.
2 eq. Cryst. Ferrocyanide Potassium 426
3 eq. Water 27
3 eq. Water 27
3 eq. Hydrogen 3
3 eq. Oxygen 24
3 eq. Cyanide Potassium 198
3 eq. Cyanogen 78
3 eq. Potassm 120
1 eq. Cyanide Potassium...... 66
2 eq. Cyanide Iron............ 108
6 eq. Oil of Vitriol 294
6 eq. Water.................. 54
6 eq. Sulphuric Acid.......... 240
720
720
3 eq. Potash 144
3 eq. Water 2
3 eq. Hydrocyanic Acid 81
1 eq. Biferrocyanide Potassium........ 174
6 eq. Water 54
3 eq. Bisulphate Potash 384
72

The salt here called biferrocyanide of potassium is termed, by Mr. Everitt, the *yellow salt*. I have prepared it with the greatest care, but have always found it to be white. Gay-Lussac also says it is white[n]. By exposure to the air it becomes blue.

β. By the action of Hydrochloric Acid on Cyanide of Silver.—This process, proposed by Mr. Everitt, yields an acid of uniform strength, and may be followed when the acid is required for immediate use.

In the *London Pharmacopœia* it is stated that diluted Hydrocyanic Acid may be otherwise prepared, when it is to be more quickly used, from forty-eight grains and a half of Cyanide of Silver, added to a fluidounce of distilled water, mixed with thirty-nine grains and a half of Hydrochloric Acid. Shake all these in a well-stoppered phial; and, after a short interval, pour off the clear liquor into another vessel. Keep this for use, the access of light being prevented.

The proportions directed by Mr. Everitt are 40 grs. of cyanide, 7 fluidrachms and 20 minims of water, and 40 minims of dilute hydrochloric acid (sp. gr. 1·129). This gentleman says, that practitioners could obtain an ounce of the acid, prepared by this process, for one shilling, while the manufacturer could obtain 50 per cent. profit by it.

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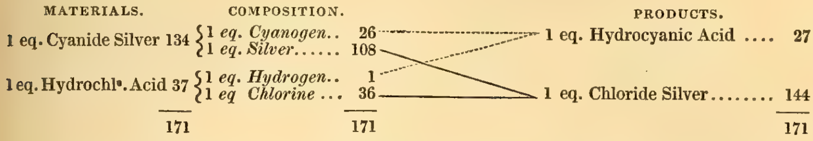
[m] *Lond. and Edinb. Phil. Mag.* Feb. 1835.

[n] *Ann. Chim. et Phys.* t. xlvi. p. 77.

The *theory* of the process is as follows:—By the mutual reaction of one equivalent or 134 parts of cyanide silver and one equivalent or 37 parts of hydrochloric acid, there are obtained one equivalent or 144 parts of chloride of silver, and one equivalent or 27 parts of hydrocyanic acid.



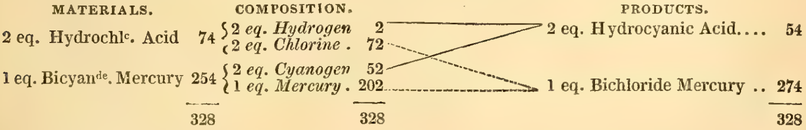
γ. *By the action of Hydrochloric Acid on Bicyanide of Mercury.*—At Apothecaries' Hall hydrocyanic acid was formerly prepared from one part of bicyanide of mercury, one part hydrochloric acid (sp. gr. 1.15), and six parts of water. The mixture was distilled until six parts had passed over. The acid thus obtained had a sp. gr. 0·995, and its standard strength was such, that two fluidrachms of it dissolved 14 grains of the red oxide of mercury, thereby indicating a strength of about 2·9 per cent. of real acid.

The *Dublin College* orders Prussic acid to be prepared from Cyanuret of Mercury, ℥j.; Muriatic Acid, *by measure*, ʒvij.; Water, *by measure*, ℥viij. Distil into a refrigerated receiver, eight ounces, *by measure*, to be kept in a well-corked bottle, in a cool and dark place.

The specific gravity of this acid is to the specific gravity of distilled water, as 998 to 1000.

The most convenient method of procuring *concentrated* or *anhydrous* hydrocyanic acid, is by the action of strong liquid hydrochloric acid on bicyanide of mercury. The vapour should be passed over carbonate of lime, to deprive it of hydrochloric acid; and over chloride of calcium, to remove the water. The receiver should be immersed in a freezing mixture, consisting of ice and chloride of sodium.

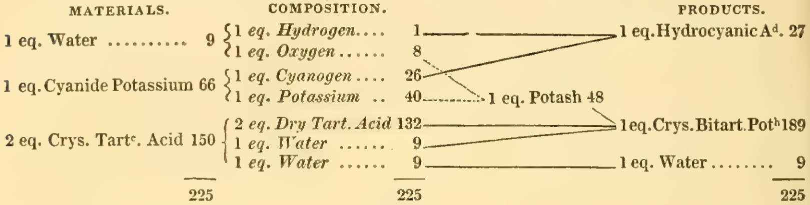
The theory of the process is as follows:—Two equivalents or 74 parts of hydrochloric acid react on one equivalent or 254 parts of the bicyanide of mercury, and form one equivalent or 274 parts of the bichloride of mercury, which remain in the retort, and two equivalents or 54 parts of hydrocyanic acid, which distil over.


MATERIALS.
COMPOSITION.
PRODUCTS.
2 eq. Hydrochl^c. Acid 74
2 eq. Hydrogen 2
2 eq. Chlorine . 72
1 eq. Bicyan^{de}. Mercury 254
2 eq. Cyanogen 52
1 eq. Mercury . 202
2 eq. Hydrocyanic Acid.... 54
1 eq. Bichloride Mercury .. 274
328
328
328

δ. *By the action of Tartaric Acid on Cyanide of Potassium.*—This process was proposed by Dr. Clarke, and adopted by Mr. Laming. The formula of the latter is the following:—22 grains of the cyanide of potassium are to be dissolved in 6 fluidrachms of distilled water, and to this solution are to be added 50 grains of crystallized tartaric acid, dissolved in 3 fluidrachms of rectified spirit. One fluidrachm of the decanted liquor contains one grain of pure hydrocyanic acid.

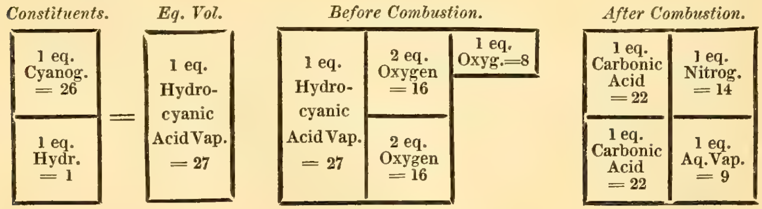
The objections to this process (which, however, has several advantages) are the trouble and expense of procuring pure cyanide of potassium, and the liability of the salt to undergo spontaneous decomposition.

The theory of the process is the following: Two equivalents or 150 parts of crystallized tartaric acid, one equivalent or 9 parts of water, and one equivalent or 66 parts of cyanide of potassium, react on each other, and produce one equivalent or 189 parts of the crystallized bitartrate of potash, which precipitates, and one equivalent or 27 parts of hydrocyanic acid, which remains in solution.



PROPERTIES. *a. Of Anhydrous Hydrocyanic Acid.*—Anhydrous hydrocyanic acid is a solid at 0° F. (some state at 5° F.), having then the appearance of crystallized nitrate of ammonia; it readily melts, forming a limpid, colourless liquid, with an intense and peculiar odour; its taste is at first cool, then hot; at 45° its sp. gr. is 0·7058, and at 64½ is 0·6969. In this state it is exceedingly volatile: a drop placed on paper freezes by its own evaporation. It unites with water and alcohol in every proportion. At 79° or 80° F. it boils, forming hydrocyanic acid vapour, which is combustible; and when mixed with oxygen, explodes. Two volumes of the vapour require two and a half volumes of oxygen gas for their complete combustion. The products are two volumes of carbonic acid gas, one volume of nitrogen, and one volume of aqueous vapour.

The following diagrams illustrate the composition as well as the products of the combustion of the gaseous acid when exploded with oxygen gas:—



Anhydrous hydrocyanic acid undergoes speedy decomposition. Yet Dr. Christison says he has kept it unchanged for a fortnight in ice-cold water.

β. Of Diluted Hydrocyanic Acid.—Diluted or medicinal hydrocyanic acid is a colourless, transparent liquid, having the taste and smell of the strong acid, but in a lesser degree. Heated in a tube it gives off a combustible vapour.

Composition.—The ultimate constituents of pure hydrocyanic acid are Carbon, Nitrogen, and Hydrogen.

	Atoms.	*Eq. Wt.*	*Theory.*	*Gay-Lussac.*
Carbon	2	12	44·4	44·45
Nitrogen	1	14	51·9	51·85
Hydrogen	1	1	3·7	3·70
Hydrocyanic Acid	1	27	100·0	100·00

	Vols.
Carbon Vapour	1 or 2
Nitrogen Gas	1
Hydrogen Gas	1
Hydrocyanic Vapour	2

But it is more usual to regard this acid as a compound of hydrogen and cyanogen, the latter substance being a bicarburet of nitrogen. On this view the composition will be as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Cyanogen	1	26	96·3
Hydrogen	1	1	3·7
Hydrocyanic Acid	1	27	100·0

	Vols.
Cyanogen Gas	1
Hydrogen Gas	1
Hydrocyanic Vapour	2

Strength of the Diluted Acid.—In the London Pharmacopœia, hydrocyanic acid is directed to be prepared of such a strength that 100 grains of it will exactly precipitate 12·7 grains of nitrate of silver dissolved in water:—the precipitate, which is cyanide of silver, should weigh 10 grains. Five parts of this precipitate correspond to one of real acid. Hence the diluted acid *Ph. L.* consists of—

Real Hydrocyanic Acid	2·0
Water	98·0
Diluted Hydrocyanic Acid (Ph. L.)	100·0

The Acidum Hydrocyanicum *Ph. Ed.* consists of "Hydrocyanic Acid diluted with about thirty parts of water." Hence its per-centage composition is as follows:—

Real Hydrocyanic Acid	3·226
Water	96·774
Acidum Hydrocyanicum (Ph. Ed.)	100·000

The Edinburgh College gives the following directions for ascertaining its strength:—

"Fifty minims [of the acid] diluted with one fluidounce of distilled water, agitated with 390 minims of solution of Nitrate of Silver [*Ph. Ed.*], and allowed to settle, will again give a precipitate with 40 minims more of the test; but a further addition of the test, after agitation and rest, has no effect. The precipitate entirely disappears in boiling nitric acid."

The Acidum Prussicum *Ph. Dub.* contains only 1·6 per cent. of real acid[a].

This discrepancy in the strength of the acid ordered in the British pharmacopœias, is greatly to be regretted. Most of the acid met with in the shops of London chemists, is stated by the label to be of "Scheele's strength." But as Scheele's process[b] gave an acid of variable strength, this statement is by no means definite. A manufacturer of large quantities of the acid informs me he sells, under the name of Scheele's acid, a diluted hydrocyanic acid, which contains 4 per cent. real acid.

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[a] Barker and Montgomery's *Observations on the Dublin Pharmacopœia.* Dubl. 1830.

[b] Scheele prepared this acid by boiling together Prussian blue, Peroxide of Mercury, and Water. Bicyanide of Mercury was obtained in solution. Iron filings and Sulphuric Acid were then added, and the products of the reaction were Hydrocyanic Acid, Metallic Mercury, and Sulphate of Iron. The liquor was then submitted to distillation.—The strength of the acid product varied with the degree of purity of the Prussian blue.

PURITY.—Diluted hydrocyanic acid should be perfectly colourless. Decomposed acid is frequently, but not invariably, coloured. It should be vaporizable by heat: this character shows the absence of fixed impurities. The presence of metallic matter is recognized by hydrosulphuric acid, which has no effect on the pure acid. If the acid strongly redden litmus, it must contain some other acid, most probably the sulphuric or hydrochloric. The presence of any foreign acid is easily determined by the *hydrargyro-iodo-cyanide of potassium.* This salt is easily formed by adding a concentrated solution of bicyanide of mercury to a solution of iodide of potassium; a precipitate of white or pearly crystalline plates of this salt is immediately formed. If a small portion of this salt be placed in diluted hydrocyanic acid, no change is observed unless some foreign acid be present: in the latter event the red biniodide of mercury immediately makes its appearance. For this test we are indebted to Dr. Geoghegan[c]. Sulphuric acid may be detected by a solution of the salts of barium. "Solution of nitrate of baryta occasions no precipitate" in the pure acid (*Ph. Ed.*); but if sulphuric acid be present, it occasions a white precipitate (*sulphate of baryta*), insoluble in nitric acid. Hydrochloric acid is recognized by nitrate of silver, which forms therewith white chloride of silver insoluble in boiling nitric acid, whereas the white cyanide of silver is soluble in nitric acid at a boiling temperature. I would observe, that the presence of either of these acids is no further objectionable, than that it creates a difficulty in the determination of the strength of the hydrocyanic acid: while, on the other hand, it confers the advantage of rendering the hydrocyanic acid much less liable to decompose. The acid prepared from ferrocyanide of potassium will keep for years (Dr. Christison has had some unchanged for two years and a half, though it was exposed to day-light), owing, it is supposed, to the presence of some sulphuric acid. Mr. Barry adds a little hydrochloric acid to all his medicinal hydrocyanic acid, in order to preserve it. As air and light hasten, though they are not essential to, the decomposition of the acid, they should be carefully excluded.

Characteristics.—The following are the best tests for hydrocyanic acid:—

1. *The odour.*—The peculiar odour of hydrocyanic acid is well known. It must not be confounded with the odour of the volatile oil of bitter almonds. Orfila says, that this is the most delicate characteristic of the acid, since it is very marked when the liquid tests give very slight indications only. But I have not found this to be invariably the case: it depends much on the nature of the mixture containing the acid.

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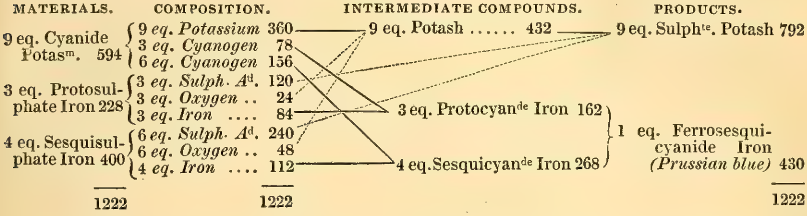
[c] *Dublin Journal*, Nov. 1835.

2. *Formation of Prussian blue (Ferrosesquicyanide of Iron).*—Add sufficient caustic potash to the suspected acid to saturate it; then a solution of some proto- and sesqui-salt of iron: the common sulphate of iron of the shops, or the tincture of the chloride, answers very well, since both these preparations usually contain the two (*prot-* and *sesqui-*)salts of iron. A precipitate is thus obtained, which is liable to considerable variation in its colour, depending on the quantity of potash and the quality of the ferruginous salt employed; it may be yellowish brown, or greenish, or bluish. Then add dilute sulphuric or hydrochloric acid, when Prussian blue (ferrosesquicyanide of iron) will immediately make its appearance, if hydrocyanic acid were present.

The formation of Prussian blue is thus accounted for. When potash is added to hydrocyanic acid, water and cyanide of potassium are generated. By the reaction of this salt on a proto-salt of iron the proto-cyanide of iron is produced, while with a sesqui-salt of iron it forms sesquicyanide of iron. The two ferruginous cyanides, by their union, constitute the ferrosesquicyanide or Prussian blue.

The following diagram explains the reaction of nine equivalents of cyanide of potassium on three equivalents of the protosulphate, and four equivalents of the sesquisulphate of iron.



3. *Nitrate of Silver.*—This is by far the most delicate test of the presence of hydrocyanic acid. It causes a white precipitate of cyanide of silver, which is soluble in *boiling* nitric acid. By this latter character cyanide is distinguished from chloride of silver. If carefully dried cyanide of silver be heated in a small glass tube, it evolves cyanogen gas, known by its combustibility and the colour (violet or bluish red) of its flame.

4. *Sulphate of Copper.*—This test is applied as follows:—Supersaturate with potash, then add sulphate of copper. A greenish blue precipitate is obtained, which, by the cautious addition of a few drops of hydrochloric acid, becomes white, if hydrocyanic acid be present. The objections to the test are, that the results are not sufficiently striking, and that an inexperienced manipulator may fail in getting any evidence of hydrocyanic acid. When excess of potash is added to hydrocyanic acid, we obtain water, cyanide of potassium, and free potash. On the addition of sulphate of copper, hydrated oxide of copper, sulphate of potash in solution, and white cyanide of copper, are formed. The hydrochloric acid is added to redissolve the oxide of copper, leaving the white cyanide of this metal.

5. *Tincture of Guaiacum and Sulphate of Copper.*—If tincture of

guaiacum be added to a very dilute aqueous solution of hydrocyanic acid, a whitish precipitate (resin of guaiacum) is thrown down. If now a few drops of a solution of sulphate of copper be added, a blue colour is produced, which is rendered more intense by the addition of rectified spirit. Pagenstecher [d], of Berne, first proposed tincture of guaiacum and hydrocyanic acid as a test for copper. I find that tincture of guaiacum and sulphate of copper, applied as directed above, form a very *sensible* test of the presence of hydrocyanic acid: but unfortunately it is not *characteristic*, since other agents also develope a blue colour with it. Thus spirit of nitric ether produces a blue colour with tincture of guaiacum.

Detection of this Acid in Cases of Poisoning.—As hydrocyanic acid is a substance which readily undergoes decomposition, it is not likely to be met with in bodies which have been interred for many days. It has, however, been recognized in one case, seven days after death, notwithstanding that the trunk had not been buried, but had been lying in a drain [e]. In recent cases the acid is readily distinguished by its odour, with which, in some instances, the whole body is impregnated. The tests for this acid, already mentioned, will sometimes detect the poison in the filtered contents of the stomach; but the foreign matters present may, occasionally, prevent their characteristic action. The best mode of proceeding in that case, is, to introduce them into a tubulated retort, to add some sulphuric acid to neutralize any ammonia which might be generated by the process of putrefaction, and to distil by means of a vapour or water bath; then apply the tests already mentioned.

It has been suggested, that hydrocyanic acid may be formed during the process of distillation by the decomposition of the animal matters. But, as Dr. Christison has justly observed, the objection appears only to rest on conjecture, or presumption at farthest. It is to be recollected, that unsound cheese has, under certain circumstances, been found to contain this acid, as already mentioned. It is not improbable that it may be found in many animal substances during their spontaneous decomposition. It is said to have been detected in ergot of rye.

Physiological Effects. α. *On Vegetables.*—Hydrocyanic acid is a poison to plants. The stamina of *Berberis vulgaris* and the leaves of *Mimosa pudica* lose their irritability when the stems bearing them are immersed in the diluted acid [f]. Seeds lose the power of germination by immersion in this acid. In those parts of lactescent plants which are poisoned by it, the milky juice does not flow from the cells or vessels in which it is contained. By chemical means it has been shewn that the acid becomes absorbed [g]. Ammonia has, in some cases, appeared to favour the recovery of plants which had been exposed to the vapour of the acid [h].

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[d] *Quarterly Journal of Science*, vol. x. p. 182.

[e] Chevallier, *Ann. d'Hygiène Publiq.* ix. 337.

[f] Macaire, *Biblioth. Universelle*, xxxi. 244.

[g] De Candolle, *Physiol. Végét.* p. 1357.

[h] Macaire, *op. cit.*

β. *On Animals generally.*—Hydrocyanic acid is an energetic poison to animals. Experiments have been made with it on the following:—*Mammalia, Aves, Reptilia, Amphibia, Pisces, Gasteropoda, Annelida, Crustacea, Insecta, and Infusoria*[i]. The general effects are very similar on all classes, and consist essentially of loss of sensation and voluntary motion, with convulsive movements. Mr. Gray, however, states that some of the larvæ of the common Musca having been put into hydrocyanic acid, remained uninjured after two or three days' exposure[j]. The cold-blooded animals are more slowly affected by hydrocyanic acid than the hot-blooded ones.

Dr. Christison states that 25 grs. of the strong acid, applied to the mouth, killed a rabbit within ten seconds. I once caused the almost instantaneous death of a rabbit by applying its nose to a receiver filled with the vapour of the pure acid: the animal died without the least struggle. If a drop of the pure acid be placed on the throat of a dog, or applied to the eye, death takes place in a few seconds. Inhaling the vapour decidedly produces death more quickly than any other mode of using the acid[k]. If the pure acid be applied to the eye of a dog, it causes opacity and whiteness of the cornea, and a copious flow of tears. In a very short time it gives rise to constitutional symptoms.

γ. *On Man.* αα. *In small or medicinal doses.*—Small doses of hydrocyanic acid sometimes relieve certain morbid conditions (as of the stomach), without producing any remarkable alteration in the condition of the general system. If the dose be cautiously increased, and its operation carefully watched, the following effects are usually observed:—a bitter but peculiar taste; increased secretion of saliva; irritation in the throat; frequently nausea; disordered and laborious respiration (sometimes quick, at others slow and deep); pain in the head, giddiness, obscured vision, and sleepiness. The vascular system is in some cases not obviously, but in others much, affected, though not uniformly; its action being sometimes quickened, at others reduced in frequency. In some instances faintness is experienced. Drs. Macleod and Granville[l] have noticed salivation and ulceration of the mouth during its medicinal use.

ββ. *In poisonous doses: convulsions and insensibility* (Epilepsy?): *if death occur, it takes place slowly.*—Immediately after swallowing the acid, a remarkably bitter taste is experienced; this is soon followed by a sensation of faintness and giddiness, with salivation, and is succeeded by tetanic convulsions and insensibility; the respiration is difficult and spasmodic; the odour of hydrocyanic acid may be recognized in the breath; the pupils are usually dilated, though sometimes contracted; the pulse is small or imperceptible. When recovery takes place it is usually very rapid, and the whole period of

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Coullon, quoted by Wibmer, *Wirkung d. Arzneim.* 3 Bd. p. 110.

[j] *Athenæum* for 1837, p. 671.

[k] For some remarks on the period of time which intervenes between the application of a poison and the first symptoms of its action, see p. 124.

[l] *Lond. Med. and Phys. Journ.* vol. xlvi. pp. 359 and 363.

suffering seldom exceeds half an hour. However, exceptions to this exist, in which the symptoms have been prolonged for several hours.

The following case, related by Dr. Geoghegan [m], is an interesting illustration of these effects:—A gentleman, aged 21, having been for some time subject to an uneasiness in the stomach, not actually amounting to gastrodynia, after having tried many remedies in vain, was induced to have recourse to hydrocyanic acid. He commenced with one minim of the Dublin Pharmacopœia, sp. gr. 0·998: this dose he repeated twelve times the first day, without any perceptible effect. On the following day he took half a drachm, with the same result. The third day his dose was a drachm, which he repeated the fourth day. On the fifth day he took a drachm and a half; still no effect of any kind. On the sixth day he increased his dose to two drachms. In about two minutes after taking this quantity, he experienced a sensation of extreme bitterness in the mouth, and having walked a few paces, was affected with great confusion, headache, and loud ringing in his ears. He now with difficulty retraced his steps, and leaning forward on a table, became insensible and fell backwards. In this state he remained altogether between three and four minutes, during which time he was violently convulsed. Two drachms of the spiritus ammoniæ aromaticus were diluted with a little water, and applied as quickly as possible to the mouth, but as the teeth were clenched it could not be swallowed. The solid sesqui-carbonate of ammonia was then applied assiduously to the nostrils; its beneficial effects were soon apparent, and he was shortly able to swallow a little fluid. Sensibility now speedily returned, and vomiting supervened, from which he experienced great relief; and at the expiration of half an hour he was quite well, with the exception of pain and feeling of distension in the head, which continued for the remainder of the day. After he had become insensible, and while leaning on the table, his thighs became rigid, and were drawn up on the abdomen; and as he was about falling, he was caught and placed on the ground. The upper extremities were then observed to be also rigid, and on drawing them from the side, they forcibly reverted to their former position; the eyes were shut, the teeth clenched, and the muscles of the face violently convulsed. It is deserving of notice that the old complaint was completely removed by this extraordinary dose.

γγ. *In poisonous doses: death rapid with or without convulsions.*—In these cases the death is so rapid that, in the human subject, the symptoms have scarcely been observed. They are probably similar to those noticed in animals,—viz imperceptible pulse, breathing not obvious, or there may be two or three deep, hurried inspirations, insensibility, and death. Convulsions may or may not be present.

The presence or absence of convulsions, as connected with the time within which death occurs in these cases, is sometimes a matter of great moment. Some years ago the life of a prisoner almost turned on this point. The following is an outline of the case [n]:—An apothecary's maid-servant at Leicester, was found one morning dead in bed. The body lay in a composed posture—the arms crossed over the trunk, and the bed-clothes pulled smoothly up to the chin. At her right side lay a phial, from which about five drachms of the medicinal hydrocyanic acid had been taken, and which was corked and wrapped in paper. It was suspected that she took the acid to occasion miscarriage, and that the apprentice was accessory to its administration; in consequence of which he was put on his trial. Now, the important question for the consideration of the medical witnesses was, could the deceased, after having drunk the poison, have had time to cork the phial, wrap it up, and adjust the bed-clothes, before insensibility came on? It was supposed that if the death were of that slow description to allow of these acts of volition, convulsions would have occurred, and the bed-clothes would have been found disordered. On the other hand, those cases in which no convulsions occur usually terminate too quickly to allow of the above acts. The medical witnesses in the above case were not agreed in opinion: the majority thought that it was impossible the deceased could have had the power of corking the bottle. The jury very properly found the prisoner not guilty.

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[m] *Dublin Med. Journ.* Nov. 1835.

[n] More fully developed in Dr. Christison's *Treatise on Poisons,* and in the *Medical Gazette,* vol. viii. pp. 577 and 797.

There are two points of inquiry connected with the action of this acid, which are interesting, more particularly in a medico-legal point of view—namely, the time at which the poison begins to operate, and the period in which it proves fatal. No absolute answer can be given to either of these questions, since the strength and quantity of the acid exhibited, and peculiarities (not known or understood) affect the result. Very strong acid, in large doses, begins to operate very speedily, especially if its vapour be inhaled. The diluted acid, on the other hand, sometimes does not produce any obvious effect for several minutes, and death may not occur for nearly half an hour. Of seven epileptic patients killed in one of the Parisian hospitals by hydrocyanic acid, some did not die for forty-five minutes[°]. But I have not found the same quantity of the same acid kill different animals of the same species in the same period of time.

Morbid Appearances.—The post-mortem appearances in cases of poisoning by this acid are the following:—Glistening and staring expression of the eyes, but which, however, is not a constant phenomenon, since it was not observed in the seven Parisian epileptics: nor is it peculiar to this poison, for the same is observed after death by carbonic acid, and in other cases (Christison): the odour of the acid is oftentimes very obvious in the blood, brain, chest, or stomach: the venous system is usually gorged with blood, while the arteries are empty: the blood is, in many cases, fluid, dark, or bluish black, and viscid or oily: the vessels of the brain and spinal marrow are frequently gorged with blood; and the cerebral ventricles sometimes contain a serous or sanguineous liquor; the lungs are, in some instances, natural—in others, turgid with blood: the internal lining of the stomach is sometimes red.

It has been stated by Magendie, that, after death by the strong acid, the muscles are not sensible to the galvanic influence. But this condition is very rarely present; indeed I have never observed it in animals killed by this acid; though Dr. Christison has occasionally found it. I have examined a considerable number of animals (principally rabbits) destroyed by hydrocyanic acid, and have always found the muscles to be powerfully affected by the galvanic influence: nor have I once met with a single case in which the heart had ceased to beat when the chest had been laid open immediately after death.

Modus Operandi.—There are several interesting subjects of inquiry connected with the operation of hydrocyanic acid, which, as they are principally theoretical, I shall briefly notice under this head.

[°] *Annales d'Hygiène Publ. et de Méd. Lég.* t. ii.

α. *Local action.*—Dr. Christison says that Robiquet's fingers became affected with numbness, which lasted several days, in consequence of their exposure for some time to the vapour of this acid[p]. This effect would appear to depend on the local action of the poison on the nerves,—a mode of operation which we are constrained likewise to admit in the case of some other narcotics[q]. The alleviation of gastrodynia by hydrocyanic acid depends probably on this benumbing effect. Some of the local effects produced by hydrocyanic acid are those of an irritant: such are, the acrid impression made by the vapour on the nose and mouth—the ptyalism—the vomiting and purging — and the redness of the mucous membrane of the stomach.

β. *Absorption.* — That hydrocyanic acid becomes absorbed, is proved by its having been detected by Krimer (quoted by Dr. Christison, p. 15), in the blood of animals poisoned with it, and by the odour of it exhaled by various parts of the body. The exhalation by the breath of the odour of the acid may sometimes serve to recognize the presence of the poison in the system[r].

γ. *Are the remote effects of this acid caused by its absorption?*—In many cases the operation of hydrocyanic acid on the system is so rapid, and death so speedily follows the application of the poison, that doubt has been entertained of its action being dependent on its absorption[s]. The principal arguments which have been adduced in favour of the agency of absorption are the following:—*first*, that the acid produces no remote effects when applied either to the nerves or brain: *secondly*, that applied to the tongue or stomach, it operates as an energetic poison, although the nerves of these parts were previously divided: *thirdly*, that if the acid be applied to a part where circulation is arrested, the operation of the poison is prevented: *fourthly*, the activity of the acid is in proportion to the absorbing powers of the part with which it is placed in contact: *fifthly*, a sufficient time always elapses between its application to the body and the first symptom of its action, to admit of its operation by absorption[t].

δ. *Organs affected.*—The parts specifically affected by this acid are the brain and true spinal system. The pain in the head, the insensibility, and the coma, are evidence of the cerebral affection; while the tetanic convulsions depend on the disorder of the true spinal system. Marx[u] mentions the following experiment performed by Wedemeyer[v] and which shows the independent action of the acid on the spinal marrow: the spinal cord of a dog was divided between the last dorsal and first lumbar vertebræ, so that the hind legs were completely paralyzed and insensible to mechanical irritants: hydrocyanic acid was then introduced into one of the hind legs;—in one minute, symptoms of poisoning commenced, the hind as well as the fore legs were violently convulsed,—and in twelve minutes the animal was dead. The affection of the respiratory and circulatory system produced by hydrocyanic acid is probably only secondary: that is, is the result of the influence of this agent over those parts of the nervous system from which the respiratory organs and heart derive their nervous power. The insensibility caused by hydrocyanic acid occurs too rapidly, in many cases, to be the result of asphyxia caused by paralysis of the muscles of respiration.

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[p] *Treatise on Poisons*, 3d ed. p. 698.

[q] See p. 13; also Müller's *Physiology*, by Baly, vol. i. p. 630.

[r] Dr. Lonsdale, in the *Edinb. Med. and Surg. Journ.* for Jan. 1839.

[s] See pp. 111, 115, and 123.

[t] See p. 124.

[u] *Die Lehre von d. Giften*, 1er Bd. 2de Abt. S. 154.

[v] *Virsuche über das Nervensystem*, S. 241, Vers. 7.

ε. *Condition of the brain and spinal marrow induced by this acid.*—The precise pathological condition of the brain and spinal cord of an animal under the influence of hydrocyanic acid, cannot be positively determined, and is, therefore, a matter of conjecture. Whatever it may be, it is probably identical with that which occurs during an epileptic paroxysm, and with that produced by loss of blood: for the essential symptoms (insensibility and convulsions occurring suddenly) are the same in all three states,—and ammonia has been found to relieve them. Now Dr. Hall[w] has shown that the convulsion from hemorrhage is spinal. Dr. Holst, Professor of Materia Medica in the University of Christiana, Norway, told me of a case of epilepsy which had been under his care, and in which it was observed that the pulse in one arm was always imperceptible during the paroxysm. On a post-mortem examination it was discovered that an anomalous distribution of the arteries existed,—so that this arm was supplied with blood by the vertebral arteries, which derived it, through the basilar artery, from the carotids. Now the cessation of the pulse during the paroxysm proved that the circulation through these vessels was temporarily interrupted. Does any similar interruption occur in poisoning by hydrocyanic acid?

ϑ. *Cause of death.*—In most cases the immediate cause of death is obstruction of respiration. In some instances it is stoppage of the heart's action. There are cases, however, in which the death is too immediate to be produced by obstructed respiration, while, on opening the chest, the heart is found still beating: this I have observed in experiments on rabbits with strong hydrocyanic acid.

η. *Cumulative effects.*—Hydrocyanic acid is not usually regarded as a cumulative poison; but a case mentioned by Dr. Baumgärtner (quoted by Dr. Christison), as well as some other circumstances, seem to favour the reverse opinion[x].

USES.—We are indebted to the Italians (Borda, Brugnatelli, and Rasori) for the introduction of hydrocyanic acid into the Materia Medica. It was first employed by them at the commencement of the present century; namely, from 1801 to 1806[y].

α. *Internal.*—By the founders of the theory of contrastimulus this acid was regarded as a powerful asthenic or contrastimulant, and, therefore, as peculiarly useful in all diseases dependent on, or connected with, excitement. Hence it was employed in inflammatory affections. But subsequent experience has fully shewn that in these cases it possesses little or no remedial power.

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[w] *Lect. on the Nerv. Syst.* p. 139.

[x] See Dr. Christison's *Treatise.*

[y] Granville, *Treatise on Hydrocyanic Acid,* 2d edit. 1820.

In this country the reputation of hydrocyanic acid, as a medicinal agent, is chiefly founded on its effects in alleviating certain painful (neuralgic) and spasmodic stomach complaints. It appears, from Dr. Granville's statements[z], that laurel-water (which contains this acid) was used in these affections by Hufeland, Haller, Thuessen, Swediaur, and Sprengel, between the years 1780 and 1796. But the first person who actually recommends hydrocyanic acid for them is Sprengel[a], in 1814. In 1819, Dr. A. T. Thomson detailed a case, which led him to infer that this acid would be an important agent in the treatment of dyspeptic affections. But the profession are principally indebted to Dr. Elliotson[b] for a full investigation of its powers in these complaints.

Every practitioner is familiar with a stomach complaint in which pain of a spasmodic character is the leading symptom, but which is not essentially accompanied by pyrexia, as in gastritis—by tendency to faint, as in cardialgia—by indigestion, as in dyspepsia, nor by loss of appetite; though one or more of these conditions may attend it. By some nosologists (as Sauvages and Sagar) it has been regarded as a distinct disease, and has been termed *gastrodynia.* It is not unfrequently accompanied by vomiting and præcordial tenderness, which, however, cannot be regarded as indicative of inflammation, for various reasons; one of which is the alleviation of it often obtained by the use of stimulants and antispasmodics. What may be the precise pathological condition of this malady I know not. Dr. Barlow[c] thinks the primary disease to be irritation or excitement of the mucous membrane of the stomach, whereby a redundant, dense, membranous, and opaque mucus is secreted, which accumulates and oppresses the stomach. The pain he supposes to arise from a contractile effort of the stomach to detach and expel the offending matter: but the immediate and permanent relief sometimes obtained by the use of hydrocyanic acid, is, I conceive, almost fatal to this hypothesis. Some time since I prescribed the acid for a lady who had suffered for months with gastrodynia, and who was persuaded, from her sensations, she had some organic disease. The remedy acted in the most surprising manner: in a few hours, to the astonishment of herself and friends, she was apparently quite well, and has since had no return of her complaint. It can hardly be imagined, that irritation of stomach can be rapidly removed by a substance which is itself an irritant. For my own part, I conceive the affection to be, essentially, a disordered condition of the nerves supplying the stomach, or of the nervous centres from whence those nerves are derived; in other words, it is a gastric neuralgia. It is frequently, but not invariably, accompanied by the irritation of stomach alluded to by Dr. Barlow. But be the proximate cause of the disease what it may, the beneficial effects of the hydrocyanic acid, in some instances of it, are most astonishing, while in others it totally fails. In all the cases in which I have tried it, I have obtained either perfect success or complete failure: I have met with no cases of partial relief. It not only allays pain, but relieves vomiting ; and in the latter cases, frequently when all other remedies fail. Dr. Elliotson mentions the following as the stomach affections relieved by it:—1st, those in which pain at the stomach was the leading symptom: 2dly, those in which the gastrodynia was accompanied by a discharge of fluid, constituting what is called pyrosis, or the water-brash: 3dly, when the excessive irritability of the stomach produces vomiting; and, 4thly, those disorders of the stomach which, in some of their symptoms, resemble affections of the heart. Dr. Prout has found it useful in gastrodynia connected with colica pictonum.

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[z] *Op. cit.*

[a] *Pharmacologia.*

[b] *Numerous Cases illustrative of the Efficacy of the Hydrocyanic Acid in Affections of the Stomach.* 1820.

[c] *Cyclopædia of Practical Medicine,* art. *Gastrodynia.*

I have also found it useful in a painful affection of the bowels, analogous to that of the stomach, and which, therefore, might with propriety be termed *enterodynia*. The most remarkable case of this kind which I have met with, was that of a gentleman, a relative of one of my pupils. He had suffered, for several months, excruciating pain in the bowels, commencing daily about two o'clock, and only ceasing at night. It was, apparently, a consequence of an ague. He had been under the care of several country practitioners, and had tried a number of remedies (including opium and disulphate of quinia) without the least benefit. I advised the employment of the hydrocyanic acid, and accordingly five minims were administered at the commencement of a paroxysm: the remedy acted like a charm: all the unpleasant symptoms immediately disappeared. Several doses of the acid were given before the period of the succeeding paroxysm, but the disease never returned; and after employing the acid for a few days longer, he went back to the country completely cured.

I have seen hydrocyanic acid used with great success to allay vomiting and purging in severe forms of the ordinary English cholera, when opium has completely failed. In Asiatic or malignant cholera it has occasionally appeared to be serviceable. I have found it successful in checking the diarrhœa of phthisical subjects, when logwood, chalk, and opium had failed.

As a remedy for affections of the pulmonary organs, hydrocyanic acid was at one time in great repute. It was said to be capable of curing slight inflammation of the lungs, without the necessity of blood-letting; of suspending or curing incipient phthisis, while in confirmed cases it smoothed the approach of death; of curing hooping-cough, and of removing all the symptoms of spasmodic asthma[c]. Experience has shown the fallacy of most of these statements. I have employed hydrocyanic acid in a considerable number of cases of phthisis, and have occasionally fancied that it relieved the cough and night-sweats; but these effects were only temporary. Cases of genuine spasmodic asthma are rare; but in two instances in which I have seen the acid employed, no relief was obtained. In allaying cough (especially the kind called spasmodic) I have, on several occasions, found it useful; but it has so frequently disappointed my expectations, that I now rarely employ it in any pulmonary diseases. I have never observed any ill effects from its use in these cases, though others assert they have. Dr. Roe[d] ascribes to this acid the power of curing simple hooping-cough, that is, convulsive cough unaccompanied by inflammatory symptoms. He gives it in conjunction with ipecacuanha and tartarized antimony. In two or three days after the use of these remedies, the violence of the paroxysms, he says, is perceptibly diminished, and their duration shortened. To a girl of ten years of age he gave a minim and a half of the acid every quarter of an hour, for twelve hours. I have not found this practice so successful as Dr. Roe's reports would lead us to expect.

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[c] See Dr. Granville's *Treatise* before referred to; and also Magendie's *Recherches sur l'emploi de l'Acide Prussique*, 1819.

It has been employed in affections of the nervous system. Cases of hysteria, epilepsy, chorea, and tetanus, have been published, in which this remedy has been found beneficial. I have seen it employed in the three first of these affections, but without any evident relief. It has been repeatedly used in hydrophobia, at the London Hospital, but without success. A most interesting case of its employment in this malady has been published in the *Lancet* (for May 10th, 1839). Under its use the hydrophobic symptoms subsided, and typhus fever supervened, of which the patient, after some days, died. Dr. Hall[e] proposes that in addition to the use of this acid, tracheotomy, as suggested by Mr. Mayo, should be tried.

Hydrocyanic acid has been administered as an anodyne in several painful affections; namely, cancer, tic-douloureux, rheumatism, &c., but, with a few exceptions, it has not been found serviceable.

As an anthelmintic it has been extolled by Brera; but the following fact, mentioned by Dr. Elliotson, will, I imagine, shew its true value:—"I have frequently employed it perseveringly without expelling one worm, when a dose of calomel has instantly brought away hundreds."

β. *External.*—The local employment of the acid has not been attended with very great success.

In chronic skin diseases, especially impetigo, prurigo, and psoriasis, the acid has been recommended by Dr. A. T. Thomson to allay pain and irritation. Schneider, of Dusseldorf, has employed one drachm and a half of hydrocyanic acid, six ounces of spirit, and as much rose water, in scaly diseases attended with severe itching, especially in eruptions upon the genital organs. On several occasions I have tried hydrocyanic washes in prurigo, but without obtaining any relief. Dr. Elliotson says he has found it efficacious in sores behind the ears, and in scabs of the face; and adds, to an irritable face it is very soothing, if employed before and after shaving. In cancer of the uterus, lotions containing this acid have been employed to allay the pain, by Frisch, of Nyborg. Osiander has also employed, in the same disease, cherry-laurel water, the active principle of which is this acid. In gonorrhœa, injections containing hydrocyanic acid have been employed with benefit. Schlegel has tried also the cherry-laurel water with the same result. Lastly, the dilute acid has been proposed as an effectual and agreeable mode of destroying vermin.

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[d] *A Treatise on the Nature and Treatment of the Hooping-Cough.* Lond. 1838.
[e] *Lect. on the Nerv. Syst.* p. 155.

Administration.—The best mode of exhibiting this acid internally is in the form of mixture. I generally give from three to five minims of the diluted acid, *Ph. L.*, three or four times a day, in about an ounce of some mild vehicle (simple water answers very well). Gum or syrup, and some flavouring ingredients (as orange-flower water, which is used on the continent) may be added. Some persons give it in almond emulsion. In some cases of irritable stomach this is objectionable.

As a wash, two fluidrachms of the dilute acid of the shops may be employed mixed with half a pint of distilled (or rose) water as a lotion in skin diseases. Frequently about half an ounce of rectified spirit is added, and Dr. A. T. Thomson recommends, in addition to this, sixteen grains of acetate of lead. The external use of this acid, in all cases (more especially if there be sores) requires great caution. Its effects on the nervous system and on the pulse must be carefully watched. In some cases it causes giddiness and faintness; and Mr. Plumbe says, in two instances it produced intermission of the pulse.

Antidotes.—The most important agents in the treatment of poisoning by hydrocyanic acid, as well as by the substances which contain it (viz. the cherry-laurel, bitter almonds, the volatile oil of these substances, &c.), are *chlorine*, *ammonia*, *cold affusion*, and *artificial respiration.*

a. Chlorine is the most powerful of these. It was first proposed by Riauz in 1822. It has been subsequently strongly recommended by Buchner, Simeon, and Orfila. It should be applied both internally and externally if possible. If chlorine water be at hand, this should be given in doses of one or two tea-spoonfuls properly diluted with water. In the absence of this, weak solutions of the chloride [hypochlorite] of lime, or the chloride [hypochlorite] of soda, may be administered. Nitro-hydrochloric acid, largely diluted, might be given where none of the above agents could be procured. The patient should be allowed to inhale, very cautiously, air impregnated with chlorine gas (developed by the action of dilute hydrochloric acid on chloride of lime.) Enemata, containing chlorine water, or a solution of chloride of lime, should also be employed.

β. Ammonia.—The spirit of sal ammoniac was proposed by Mead[f] as an antidote for laurel water. In 1822, ammonia was recommended by Mr. J. Murray as an antidote for hydrocyanic acid; and its value has been admitted by Buchner, Orfila, Dupuy, and Herbst: but it is certainly inferior to chlorine; and, therefore, should be used only in the absence of this. If the patient be able to swallow, the liquor ammoniæ, diluted with eight or ten parts of water, should be exhibited, and the vapour of ammonia or its carbonate inhaled: the latter practice is most important, and should not be omitted. Orfila says that ammonia is of no use when introduced into the stomach, but that the inhalation of the vapour will sometimes preserve life. Great caution is requisite in the employment of it (see p. 300). In the absence of ammonia the inhalation of the vapour of burnt feathers might be employed. Ammonia cannot be useful, as an antidote, by its chemical properties merely, since hydrocyanate of ammonia is a powerful poison.

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[f] *Mechan. Account of Poisons*, 5th edit. p. 275, 1756.

γ. *Cold Affusion* has been strongly recommended by Herbst,[g] and is admitted by Orfila to be a valuable remedy, though he thinks it is inferior to chlorine. Herbst says that its efficacy is almost certain when it is employed before the convulsive stage of poisoning is over, and that it is often successful even in the stage of insensibility and paralysis.

δ. *Artificial respiration* ought never to be omitted. Of its efficacy I am convinced from repeated experiments on animals. I once recovered a rabbit by this means only, after the convulsions had ceased, and the animal was apparently dead. It is an operation easily effected, and will be found a powerful assistant to chlorine or ammonia, by enabling it to get into the lungs when natural respiration is suspended. To produce respiration, make powerful pressure with both hands on the anterior surface of the chest, the diaphragm being at the same time pushed upward by an assistant. Inspiration is effected by the removal of the pressure and the consequent resiliency of the ribs.

Other remedies (as turpentine) have been recommended, but they will not bear comparison (if, indeed, they possess any efficacy) with those now mentioned. Blood-letting has been advised, in vigorous subjects, when respiration has been established, and the skin is livid[h].

ORDER VIII. COMPOUND OF BORON AND OXYGEN.

AC'IDUM BORA'CICUM. BORACIC ACID.

HISTORY.—Beccher[i] "was undoubtedly the first discoverer of boracic acid, though the credit of the discovery has usually been given to Homberg," who, in 1702[ii], obtained it in small shining plates, which have been called *Sedative* or *Narcotic Salt* (*Sal sedativum Hombergi*). In the year 1776 it was discovered in the lagoons (*Lagoni*) of Tuscany by Hoefer[j] and Mascagni[k], and more recently by Mr. Smithson Tennant[l], Dr. Holland[m], and Mr. Lucas[n], in the crater of Vulcano, one of the Lipari Islands.

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[g] *Archiv. f. Anat. et Phys.* 1828.; quoted by Dr, Christison.
[h] Devergie, *Méd. Lég.* t. ii. p. 825; also Lonsdale, *op. supra cit.*
[i] Thomson's *History of Chemistry*, vol. i p. 248. Lond. 1830.
[ii] *Histoire de l'Academie Royale des Sciences,* 1702; *Memoires,* p. 50.

NATURAL HISTORY.—Boracic acid is peculiar to the inorganised kingdom. It is found both free and combined.

α. *Free Boracic Acid.*—The boracic acid *lagoons* of Tuscany are spread over a surface of about thirty miles. There are nine establishments for the manufacture of this acid; viz. at Monte Cerboli, Monte Rotondo, Sasso, Serazzano, Castelnuovo, San Frederigo, Lustignano, Lurderello, and Lago. They are the property of one individual (M. Tarderel, now Count de Pomerance), to whom they are the source of great wealth. The earth (principally calcareous) of this part continually evolves aqueous and sulphurous vapours, which, when they burst with a fierce explosion, produce boracic acid[o]. The phenomena are explicable on the supposition, that water gains access to immense masses of sulphuret of boron contained in the interior of the earth. By the mutual reaction of these substances, great heat, boracic acid, and sulphuretted hydrogen, would be evolved. The latter taking fire would produce water, sulphur, and sulphurous acid[p]. In consequence of being found at Sasso, native boracic acid has obtained the name of *Sassoline.*

β. *Combined with bases.*—Boracic acid is found native combined with soda (forming *Tincal*[pp]), and with magnesia (constituting *Boracite*). It is also found in the minerals called *Datholite*, *Botryolite*, *Schorl*, *Apyrite*, and *Axynite.*

PROCESS OF MANUFACTURE.—Boracic acid is obtained in Tuscany in the following manner:—"Round the more considerable fissures a circular basin is dug, about four feet deep, and usually three or four yards across. These basins, which are called *lagoni*, being situated at different levels, the water of a rivulet is admitted into them, which, mixing with the black mud at the bottom, is made to boil up violently by the issues of vapour within its circuit. The water is generally confined in each basin for twelve [twenty-four, *Payen*] hours at a time, during which period it becomes saturated to a certain extent with acid from the steam which has passed through it. It is then drawn off from the higher basin to one beneath it, where it remains an equal length of time, till at length it reaches a building at the bottom of the hill, in which the process of evaporation is conducted." Here it enters a reservoir or cistern, where it is allowed to repose till it has deposited the mud which it held in suspension. Having cleared itself of impurities, the water is then drawn off from the cistern into flat leaden pans, under which some of the natural steam is conducted by brick drains about two feet under ground, and by this heat is evaporated. This process requires about sixty hours, the water passing successively from the pans at the upper extremity into others at the centre, and from thence into others at the lower extremity of the building, by means of leaden siphons.

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[j] *Memoria sopra il sale sedativo di Toscana ed il Borace*, &c. Firenze, 1778. Uebers von B. F. Hermann. Wien. 1782.

[k] *Memorie della Societa Italiana*, viii. 487.

[l] *Transactions of the Geological Society*, vol. i. p. 388. 1811.

[m] *Travels in the Ionian Islands, Albania, Thessaly, Macedonia, &c. during the years* 1812 & 1813, p. 9. Lond. 1815.

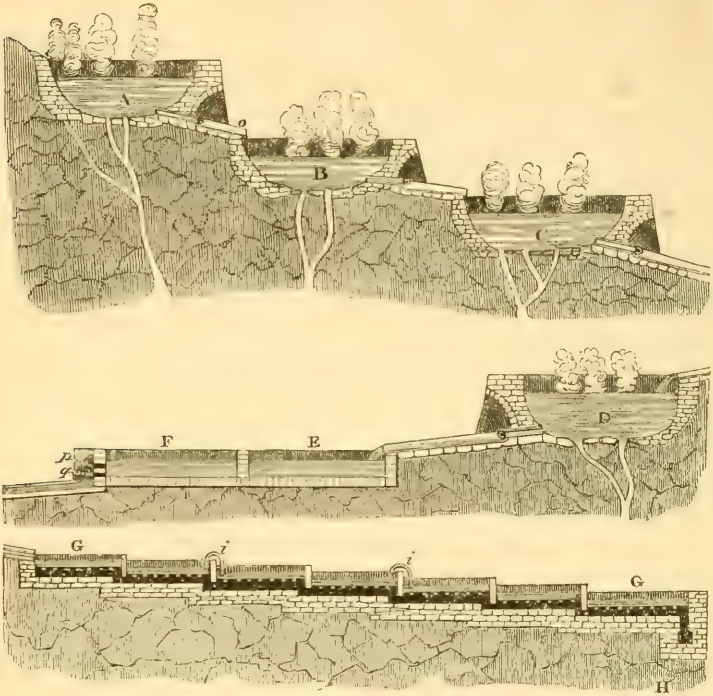
[n] *Ann. Chim. et de Physiq.* t. ii. p. 443. 1819.

[o] For further details consult Tancred, *On the Collection of Boracic Acid from the Lagoni of Tuscany*, in the *Transactions of the Ashmolean Society*, vol. i., Oxford, 1837; Dr. Bowring, *On the Boracic Acid Lagoons of Tuscany*, in *The Lond. and Edinb. Philosoph. Magazine*, vol. xv. p. 21. Lond. 1839; and Payen, *Ann. Chim. et Phys.* 1841.

[p] Dumas, *Traité de Chimie*, t. i. p. 380. Paris, 1828.

[pp] See *Sodæ Biboras.*

FIG. 69.



Boracic Acid Lagoons of Tuscany.

A, B, C, D. Lagoons.—The vapours enter at the bottom, and escape through the water into the air. When the water in the upper lagoon, A, is sufficiently charged with acid, it is allowed to run through the tube, *o*, into the lower lagoon, B. In this way it passes successively from B to C, from C to D, and from D into the reservoir, E.

E, F. Reservoirs or Cisterns.—In these the solution is allowed to rest, and deposit mechanical impurities. By the removal of the upper plug, *p*, the solution escapes into the upper evaporating pan, G.

G, G. Leaden Evaporating Pans.—They are supported by rafters, and are heated by the aqueous vapours, which enter at H and are confined in drains. The acid solution is conveyed from one pan to another by means of leaden siphons, *i i*.

Having arrived at a proper state of concentration, it is then conducted into wooden tubs, in which it cools for about five days, during which the crystallization of boracic acid takes place on the sides of the tubs, and on the stick in the centre. The acid having been removed from the tubs is placed in a basket to drain, and is then spread on the floor of a closed chamber, heated by vapour, to dry. The acid, thus prepared, is sent in casks to Leghorn[q].

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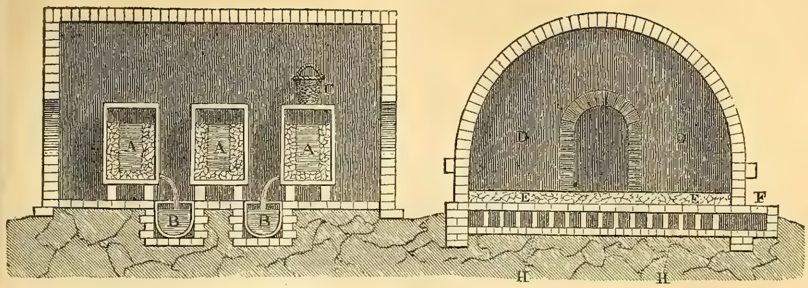
[q] Tancred, *op. supra cit.*; also Bowring, *op. supra cit.*; and Payen, *op. supra cit.*

FIG. 70.



Crystallization and Drying Chambers.

A, A, A. Wooden tubs lined with lead, in which the acid crystallizes.
B, B. Mother liquor.
C. Basket in which the crystallized acid is placed to drain before it is conveyed to the drying chamber.
D, D. Drying chamber.
E, E. Boracic acid drying on the floor (F), between which and the lower floor (H) the hot vapour circulates.

Boracic Acid may also be obtained by dissolving borax in hot water, and adding half its weight of oil of vitriol. As the solution cools, crystals of boracic acid (retaining a little sulphuric acid) are deposited, which must be well washed. Or borax may be decomposed by hydrochloric acid, by which a purer boracic acid is procured.

PROPERTIES.—Crystallized boracic acid occurs in the form of white, transparent, pearly, hexagonal scales, which are odourless, have a weak, scarcely acid, taste, and communicate a wine-red tint to litmus. At 60° the crystallized acid requires 25·66 times its weight of water to dissolve it, but only 2·97 times at 212°. It dissolves readily in spirit of wine. When sufficiently heated it evolves its water of crystallization, melts, forming a transparent liquid, which, by cooling, becomes a brittle glass (*vitrified boracic acid*).

Characteristics.—An alcoholic solution of boracic acid burns with a beautiful green flame. A hot aqueous solution of the acid renders turmeric paper brown, like the alkalis[r]. Before the blowpipe, boracic acid fuses, and forms a glass which may be tinged blue by chloride of cobalt, and rose-red by the terchloride of gold. A mixture of one part of vitrified boracic acid, finely pulverised, two parts of fluor spar, and twelve parts of oil of vitriol, evolves, by heat, the fluoride of boron, recognised by its forming dense white fumes in the air, and by its charring paper, wood, &c.

COMPOSITION.—The following is the composition of boracic acid:—

	Atoms.	*Eq.Wt.*	*Per Ct.*	*Berzelius.*
Boron	1	10	29·41	31·18
Oxygen	3	24	70·59	68·82
Dry Boracic Acid	1	34	100·00	100·00

	Atoms.	*Eq.Wt.*	*Per Ct.*	*Berzelius.*
Dry Boracic Acid	1	34	55·74	56
Water	3	27	44·26	44
Crystallized Boracic Acid	1	61	100·00	100

PHYSIOLOGICAL EFFECTS AND USES.—Though sedative properties were formerly ascribed to this acid, it is probably inert, or nearly so.

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[r] Faraday, *Quarterly Journal of Science*, vol. ix. p. 403.

Cullen[s] gave it in large doses without observing that it produced any effect on the human body. It is, therefore, not employed in medicine; but it is extensively used in the manufacture of borax. (See *Sodæ Biboras.*)

ORDER IX. PHOSPHORUS AND PHOSPHORIC ACID.

1. PHOS'PHORUS, *L.*—PHOSPHORUS.

HISTORY.—This substance was discovered, in 1669, by Brandt, an alchymist at Hamburgh; and received its name from being luminous in the dark (from φῶς, *light*, and φέρω, *I carry*).

NATURAL HISTORY.—Phosphorus is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—It is comparatively rare in the mineral kingdom. Various phosphates are found native, but in small quantities: those of Lime, Lead, Iron, Copper, Manganese, Uranium, and Yttria, may be mentioned as examples. Phosphate of Lime is an important constituent of the organic exuviæ entombed in the fossiliferous rocks.

β. IN THE ORGANISED KINGDOM.—Phosphoric acid, free, or combined with lime, potash, or iron, is found in various vegetables[t]. Phosphorus is a constituent of animals: in some cases it is in combination with oxygen, and a base, as in the bones, urine, &c.; in other instances, as in the brain, it is uncertain in what form it exists.

PREPARATION.—Phosphorus is obtained from bone-ash, which is principally composed of the sub- or two-thirds *phosphate of lime.* The bones of the sheep are preferred, as the ash which they yield is less compact, and more easily attacked by the acid. Sulphuric acid is gradually added to the bone-ash previously made into a thin pap with water. Carbonic acid is evolved, while sulphate and a soluble superphosphate of lime are formed. Water is added, and at the end of twenty-four hours the liquor is filtered and evaporated in leaden or copper pans to the consistence of syrup or honey. It is then mixed with charcoal, dried, and distilled in an earthen retort. The charcoal abstracts the oxygen from the phosphoric acid of the superphosphate, setting free the phosphorus, which is volatilized, and condensed in water contained in a copper receiver. It is afterwards purified by pressing it through shamoy leather under water. It is subsequently moulded for sale into cylinders, by melting it in water, and sucking it up a slightly conical glass tube, which is then immersed in cold water, when the solidified stick of phosphorus falls out[u].

PROPERTIES.—It is a pale yellow, semitransparent, crystallizable, highly combustible solid. Mitscherlich says the crystals are rhombic dodecahedrons; so that they belong to the regular or cubic system. Light, especially violet light, reddens it.

Its sp. gr. is 1·77. At ordinary temperatures it is flexible, but at 32° is brittle. It melts at 108°, and boils at 550° F. It gives off a small quantity of vapour at ordinary temperatures. In the atmosphere its fumes are luminous in the dark, in consequence of a slow combustion: they have the odour of garlic. By keeping in water, phosphorus becomes coated by a white substance, by some regarded as an oxide, by others as the hydrate of phosphorus. By Rose it is considered to be phosphorus in a peculiar mechanical state. Phosphorus is insoluble in water, but soluble in ether, and the oils both fixed and volatile. It may be reduced to powder by melting it under water, and shaking in a closed vessel until cold. Its equivalent by weight is 16.

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[s] *Materia Medica,* p. 341.

[t] De Candolle, *Phys. Végét.* pp. 383, 387, and 390.

[u] For further details consult Soubeiran, *Nouveau Traité de Pharmacie,* t. ii. p. 260, 2de éd.; also Ure, *Dict. of Arts.*

Characteristics.—Phosphorus, in substance, is easily recognized by its waxy appearance and garlic-like odour; by its fuming in the air, and being phosphorescent or luminous in the dark; by friction or gentle heat causing it to inflame; and, lastly, by its burning with a most intense white light and a white smoke of phosphoric acid, in air, or still better in oxygen gas. A solution of phosphorus in oil or ether, may be known by its garlic-like odour, and, when rubbed on the skin, by its rendering the latter luminous in the dark.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.* — According to Marcet it is poisonous to plants.

β. On Animals generally.—Water impregnated with phosphorus acts as an aphrodisiac to drakes[v]. Phosphuretted oil is a stimulant to horses: blood drawn from the veins of horses under its influence has a phosphoric odour[w]. If phosphuretted oil be injected into the jugular vein, or into the cavity of the pleura of a dog, white vapours of phosphorus are evolved from the mouth, and death shortly takes place. The phosphorous acid (formed by the combustion of the phosphorus) inflames the lungs in its passage through the delicate pulmonary vessels. Introduced into the stomach of animals, phosphorus acts as a caustic poison. The corrosion is supposed to depend on the action of the phosphorous acid (formed by the combination of the phosphorus with the oxygen of the air contained in the pulmonary canal) on the tissue with which it is in contact[x].

γ. On Man.—In *small doses*, phosphorus acts as a powerful and diffusible stimulant, exciting the nervous, vascular, and secreting organs. It creates an agreeable feeling of warmth at the epigastrium, increases the frequency and fulness of the pulse, augments the heat of skin, heightens the mental activity and the muscular powers, and operates as a powerful sudorific and diuretic. Its aphrodisiac operation has been recognized by Alphonse Leroy, and Bouttatz[y], by experiments made on themselves. In *somewhat larger doses* it causes burning pain, vomiting and purging, with extreme sensibility of the stomach, which lasts for several days[z]. In *still larger doses*, it causes inflammation of the stomach and bowels. Its activity as a caustic poison depends, according to Orfila, on its absorbing oxygen, and thus becoming converted into an acid which acts as a corrosive, like the other mineral acids. Hence, therefore, etherial and oleaginous solutions are more active poisons, inasmuch as the oxidation of the phosphorus is effected more rapidly. Comparatively small doses have in some cases proved fatal. Dr. Christison[a] mentions one instance in which 1½ grains, in another instance 3 grains, caused death[b]. Cases, however, are reported, in which 6, 10, and even 12 grains have been swallowed without any hurtful effects; but doubts have been entertained as to the correctness of the statements. Thus Merat and De Lens[c] think that the phosphorus employed in these cases must have undergone some chemical change. I once administered 16 grains of apparently good phosphorus to a man without any injurious effect. The person here alluded to was Chabert, some years ago renowned in London under the name of the "*Fire King*." I carefully weighed the above quantity, which was placed in a spoon, introduced into his mouth, and washed down by a tumblerful of water. He offered to take this dose daily. Within ten minutes after swallowing the phosphorus, he left the room for about a quarter of an hour.

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[v] Alph. Leroy, quoted by Bayle, *Biblioth. de Thérap.* t. ii. p. 28. Paris, 1830.

[w] Pilger, quoted by Bayle.

[x] Orfila, *Toxicol. Génér.*

[y] Bayle, *op. cit.*

[z] See an experiment made by Sundelin on himself, *Handb. der Heilmittellehre*, 2^{c}. Bd. S. 213.

USES.—In this country, phosphorus is rarely employed, and, therefore, it will be unnecessary to enter minutely into its uses. It has been strongly recommended in those cases attended with great prostration of the vital powers, as in the latter stages of typhus fever, dropsies, &c.; in some chronic diseases of the nervous system (as epilepsy, paralysis, melancholy, mania, amaurosis, &c.,) occurring in debilitated subjects. In some of the exanthemata, as measles, it has been administered to promote the re-appearance of the eruption when this, from some cause, had receded from the skin. In *impotentia virilis* of old and debilitated subjects, in cholera, and in some other maladies, it has also been exhibited. Paillard recommends phosphorus as a caustic, in the place of moxa, than which, he says, it is more convenient and safe[d].

ADMINISTRATION.—Phosphorus cannot be given with safety in the solid form. It may be administered dissolved in ether, or, still better, in oil.

ANTIDOTES.—In poisoning by phosphorus, large quantities of mild demulcent liquids are to be exhibited, so as to envelop the phosphorus and exclude it from the air contained in the alimentary canal. Magnesia should be given, in order to neutralize the phosphorous and phosphoric acids which may be formed. Parts burned with phosphorus are to be washed with a weak alkaline solution, to remove any adhering acid which might serve to keep up irritation.

1. **TINCTURA ÆTHEREA CUM PHOSPHORO**, *French Codex*.—(Phosphorus 4 parts, Sulphuric Ether 200 parts by weight. Macerate for a month, in well-stoppered bottles covered with black paper, occa-

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[a] *Treatise on Poisons.*

[b] In the *Morning Herald* of June 17, 1840, is a report of an inquest held on the body of a child killed by sucking the phosphoric ends of lucifer matches.

[c] *Dictionnaire de Matière Médicale.*

[d] *Lond. Med. Gaz.* vol. ii. p. 254.

sionally shaking. Preserve it in small bottles, well stoppered and covered with black paper). The quantity of phosphorus dissolved is about 4 grains for each ounce of ether. Dose from 5 to 10 drops. Some objection has been raised to the use of this prepartion on the ground that, by the evaporation of the ether, the phosphorus will be set free in the stomach, and might ignite.

2. **OLEUM PHOSPHORATUM**, *Ph. Borussica.*—(Phosphorus dry and cut into small pieces, gr. xij.; Almond Oil, recently prepared, ℥j. Melt the phosphorus in the oil by the aid of warm water: then agitate until it appears to be dissolved). One ounce of oil dissolves about 4 grs. of phosphorus. Dose from 5 to 10 drops. It should be administered in some mucilaginous liquid, or made into an emulsion. It may be *aromatized* by a few drops of some essential oil, as of bergamot.

2. AC'IDUM PHOSPHOR'ICUM DILUTUM, *L.*—PHOSPHORIC ACID.

History.—Phosphoric acid was first distinguished by Marggraf, in 1740.

Natural History.—(See *Phosphorus*).

Preparation.—In the London Pharmacopœia, diluted phosphoric acid is ordered to be thus prepared:—

Take of Phosphorus, ℥j.; Nitric Acid. f℥iv.; Distilled Water, f℥x. Add the phosphorus to the nitric acid, mixed with the water, in a glass retort placed in a sand-bath; then apply heat until eight fluidounces are produced [distilled]. Let these be again put into the retort that eight fluidounces may distil, which are to be rejected. Evaporate the remaining liquor in a platinum capsule until only two ounces and six drachms remain. Lastly, add to the acid, when it is cold, as much distilled water as may make it accurately measure twenty-eight fluidounces.

In this process six equivalents or 96 parts of phosphorus react on five equivalents or 270 parts of nitric acid, and abstract fifteen equivalents or 120 parts of oxygen, with which they form six equivalents or 210 parts of phosphoric acid, while five equivalents or 150 parts of the binoxide of nitrogen are evolved.

MATERIALS.		COMPOSITION.		PRODUCTS.	
5 eq. Nitric Acid......	270	5 *eq. Nitrogen* ..	70	5 eq. Binox. Nitrogen....	150
		10 *eq. Oxygen*....	80		
		15 *eq. Oxygen*....	120		
6 eq. Phosphorus	96	....		6 eq. Phosphoric Acid....	216
	366				366

If strong nitric acid be employed, instead of the dilute acid ordered in the Pharmacopœia, the re-action is so energetic that explosion and combustion are sometimes the consequence. In such cases some nitrate of ammonia is usually developed: the ammonia being formed by the union of the nitrogen of the acid with the hydrogen of the water.

Properties.—The aqueous solution of phosphoric acid (*acidum phosphoricum dilutum*, Ph. L.) prepared as above, is a colourless and odourless liquid. It possesses the usual characteristics of an acid;

that is, it is sour to the taste, reddens litmus, and neutralizes bases. Its sp. gr., according to the London Pharmacopœia, is 1·064. By evaporation it acquires the consistence of treacle (*hydrated phosphoric acid*): and when exposed to a higher temperature, it loses water and becomes *pyrophosphoric acid.* At a dull red heat a further evolution of water takes place, and a compound is formed, called *metaphosphoric acid:* this is fusible, and by cooling concretes into a transparent solid, called *glacial phosphoric acid.*

Characteristics.—If phosphoric acid be saturated with an alkali (soda) so as to form a soluble phosphate, it may be distinguished from all other acids by the following characters:—it throws down, with the soluble salts of lime, lead, and baryta, white precipitates (*phosphates*) soluble in nitric acid: with the nitrate of silver it causes a yellow precipitate (*subsesquiphosphate of silver*) soluble in nitric acid and in ammonia: hydrosulphuric acid causes no change of colour or precipitate with it: if the soluble phosphate be heated to redness, it is converted into a pyrophosphate, which gives, with the nitrate of silver, a white precipitate (*pyrophosphate of silver*).

PURITY.—The following are the qualities of this preparation, as given in the London Pharmacopœia:—

> "Chloride of barium or nitrate of silver being added, whatever is thrown down is readily dissolved by nitric acid. Strips of copper and silver are not at all acted upon by it, nor is it coloured when hydrosulphuric acid is added. Its sp. gr. is 1·064; 42 grs. of [crystallized] carbonate of soda are saturated by 100 grs. of this acid, and nothing is thrown down."

The chloride of barium is to detect sulphuric acid: while the nitrate of silver detects hydrochloric acid. Should any free nitric acid be present, a portion of the copper and silver would be dissolved; and the solution would yield a dark precipitate with hydrosulphuric acid. The quantity of carbonate of soda saturated indicates the per centage strength to be 10·5. The absence of any precipitate, on the addition of carbonate of soda, shows that no phosphate of lime or any other earthy phosphate is present.

COMPOSITION. — Pure anhydrous phosphoric acid is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Dulong.*	*Davy.*
Phosphorus	1	16	44·44	44·05	44·8	42·6
Oxygen	2½	20	55·56	55·95	55·2	57·4
Phosphoric Acid	1	36	100·00	100·00	100·0	100·0

Mr. Phillips says, that 100 grains of the diluted acid of the Pharmacopœia saturate 42 grains of [crystallized] carbonate of soda. This indicates its composition to be as follows:—

	By Weight.
Phosphoric Acid	10·5
Water	89·5
Diluted Phosphoric Acid, *Ph. L.*	100·0

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—This acid is poisonous to plants[e].

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[e] Gœppert, quoted by De Candolle, *Phys. Végét.*

β. *On Animals.*—Very few experiments have hitherto been made with it on animals. Orfila[f] found that a strong solution of it acted like sulphuric acid. Thrown into the veins of a dog, it coagulated the blood and killed the animal within ten minutes. Introduced into the stomach, it acted as a powerfully corrosive poison.

γ. *On Man.*—Diluted phosphoric acid produces the usual effects of the diluted mineral acids, and which I have before noticed (pp. 189, 201, and 212). It is, therefore, denominated tonic and refrigerant, and may be employed wherever the mineral acids are indicated. It is milder, more assimilable, and, therefore, less likely to disagree with the digestive organs, than sulphuric acid, with which, in its action, it is usually compared. These qualities it perhaps derives from its being, as Burdach[g] expresses it, "less heterogeneous to the human organism, since it has a considerable share in the composition of it." The same authority also observes, that besides fulfilling the indications of the mineral acids, "it much exalts the excitability when the organism is weak."

Various effects have been ascribed to this acid, which require to be further investigated ere they are admitted. Thus Hecker[h] says, it exerts a special influence over the nervous system, in virtue of which it possesses the power of allaying pain and spasm. Lentin[i] considers it to be endowed with the specific power of influencing secreting surfaces and the bones, whereby it is enabled to ameliorate various morbid conditions of these parts. Sundelin[j] regards it as a stimulant and tonic to the sexual organs. Various effects have been ascribed to it by Herder[k].

Uses.—Phosphoric acid has been employed in the same cases in which sulphuric and other mineral acids have been used, and under the same regulations. It may be employed for a longer period, without disturbing the digestive functions, than the other agents of this class.

It has been used in certain cases rather on theoretical than practical grounds. Thus its power of dissolving phosphate of lime has led to its employment in those forms of lithiasis attended with phosphatic deposits in the urine,—in ossification of the arteries and cardiac valves,—and in exostosis and other osseous tumours. Lentin used it as a local agent to check caries, from a notion that this disease depends on a deficiency of phosphoric acid in the part affected. Woulff applied it to promote the formation of bone.

There are several other diseases against which this acid has been administered. Thus it has been given in blenorrhœa and leucorrhœa, when the secreted fluid was thin and acrid (Sundelin),—in profuse suppuration, to diminish the quantity and improve the quality of the secreted matter,—in hysterical affections of young and irritable subjects, Sundelin has found it useful,—in impotency of the male (Berends),—in diabetes, and in jaundice. Dr. Paris[l] has found it to assuage the thirst so commonly present in diabetes, more effectually than any other acidulated drink.

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[f] *Toxicolog. Génér.*
[g] *Arzneimittellehre,* Bd. 3. S. 395. 1809.
[h] *Arzneimittel.* Bd. 2. S. 305.
[i] *Beitrage zur ausüb. Heilk.* Bd. 2. S. 139.
[j] *Heilmittell.* Bd. 2. S. 234.
[k] *Hufeland's Journ.* Bd. 9. St. 3. S. 148.

ADMINISTRATION.—Internally the dilute phosphoric acid should be given in doses of from ten minims to a fluidrachm, properly diluted. Mixed with eight or ten times its volume of water, it may be employed as a wash in caries.

ANTIDOTES.—(See *Sulphuric Acid.*)

ORDER X. SULPHUR AND ITS NON-METALLIC COMPOUNDS.

1. SUL'PHUR, *L. E.*—SULPHUR OR BRIMSTONE.

HISTORY.—Sulphur has been known from the most remote periods of antiquity. It is mentioned by Moses[m], Homer[n], and other ancient writers.

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—*Native* or *virgin sulphur* occurs in two forms: either imbedded in rocks (*common native sulphur*), or produced by sublimation (*volcanic sulphur*). In Sicily[o] it is found in beds in a blue clay formation, which, in the opinion of Dr. Daubeny, is more recent than chalk, but is of the same age with the gypsum beds in the neighbourhood of Paris. Solfatara (called by the ancients *Forum Vulcani* or the *Court of Vulcan*), a kind of half-extinct volcano, in the vicinity of Naples, is celebrated for its native sulphur, which is collected in considerable quantities for the purposes of commerce[p]. Sulphur is also found in the mineral kingdom in a state of combination. Thus sulphurous acid gas rushes out from volcanoes. Sulphuric acid is found native both in the free and combined states: hydrosulphuric acid gas is evolved from the pure sulphurous or hepatic waters (see p. 267), and from the soil in some other places: lastly, sulphur is found in combination with metals. Dr. Thomson[q] mentions fourteen native sulphurets and seventeen sulphur salts.

β. IN THE ORGANISED KINGDOM.—Sulphur is found in *Liliaceæ* (as in garlic); in *Cruciferæ* (as in mustard); in *Umbelliferæ* (as in asafœtida), and in many other orders of plants. The alkaline and earthy sulphates are frequently met with in vegetables. Sulphur is also a constituent of some animal substances (thus it is found in eggs, urine, &c.); sulphates are found in the urine.

PREPARATION.—Sulphur is procured in two ways; by the purification of native sulphur, or by the decomposition of the native sulphurets. The sulphur of British commerce is almost exclusively obtained in the first way. It is brought principally from Italy and Sicily. During the year 1830 no less than 236,338 cwts. of rough brimstone were imported from Italy and the Italian islands[r].

α. Purification of native sulphur.—In Sicily, from whence most of this substance is procured, the native sulphur is submitted to a rude process of fusion: it is collected in heaps, which are set fire to on the surface: the heat developed by the combustion of one portion fuses another[s].

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[l] *Appendix to the* 8th *ed. of the Pharmacologia.* Lond. 1836.

[m] *Genesis*, xix. 24.

[n] *Iliad*, lib. xvi.

[o] Some mineralogists entertain the opinion that Sicilian sulphur is of organic (animal) origin. See *Athenæum* for December 1st, 1838; also Leonhard, *Handbuch der Oryktognosie*, S. 599. Heidelberg. 1826.

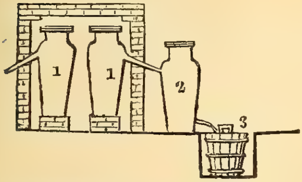
[p] Sir W. Hamilton, *Campi Phlegræi*, 1776.

[q] *Outlines of Mineralogy*, &c. vol. i. p. 76.

[r] *Parliam. Ret.* 367, ordered to be printed, April 1832.

Another mode of purifying native sulphur is to distil it in earthen pots. These are arranged in two rows in a large oblong furnace, fig. 71 (1, 1), the top of each pot, which serves for the introduction of the sulphur and for the removal of the residuum, being kept closed during the operation. The upper and lateral part of each pot communicates with an inclined tube of about two inches diameter and fourteen long. When the fire is lighted in the furnace, the sulphur fuses and sublimes, and passes through this tube into another pot (2), placed on the outside of the furnace, and perforated near its bottom to allow the melted sulphur to flow into a pail (3) containing water, where it congeals, and forms the rough or crude sulphur (*sulphur crudum*)[t].

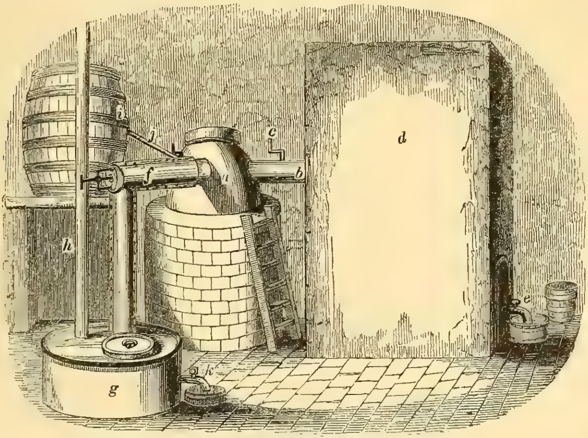
FIG. 71.



Distillation of Native Sulphur.

Crude sulphur is purified in this country. The process formerly adopted was to submit it to fusion in an iron cauldron: the earthy impurities subsided, and the liquid sulphur was ladled out and cast in moulds. The improved method of purification is to submit it to distillation in an iron still.

FIG. 72.



Distillation of Sulphur.

a. Cast-Iron Still.
b. Communication between the still and the sulphur chamber (*d*).
c. Handle by which this communication can be shut off.
e. Vent Pipe, one end of which opens into the chamber, the other dips into water.
f. Communication between the still and the receiver (*g*).
h. Vent pipe.
i. Water butt which supplies cold water, by the pipe *j*, to cool the distilled sulphur, and afterwards runs off at *k*.

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[s] Daubeny, *Description of Volcanoes*, p. 197.
[t] Dumas, *Traité de Chimie*, t. 1er. p. 121.

For this purpose crude sulphur is put into an iron pot (fig. 70), set in brickwork, over a proper fire. To this is adapted an iron head (*a*), removable by a crane, and communicating by two tubes or necks (*b* and *f*), the one with the sulphur chamber (*d*), the other with the iron receiver (*g*), which is immersed in water. The communication (*f*) between the still and the receiver being shut off, the sulphur distils into the sulphur chamber (*d*), on the walls of which it is deposited in a pulverulent form. When obtained in this state it is called *Flowers of Sulphur.* The door into this chamber is placed near the ground, and is closed when the process is going on. If the communication (*b*) between the still and the sulphur chamber be shut off by turning the handle (*c*), and the communication (*f*) between the still and the receiver (*g*) opened, the sulphur distils over and condenses into a liquid which, when solidified, constitutes the *refined sulphur* of commerce. The elbow-pipe, which forms the communication between the still and the receiver, is encased in a metal jacket, between which and the tube a current of cold water is continually flowing from the butt (*i*), and, after passing around the receiver (*g*), escapes at *k*. The top of the receiver is perforated by a vent pipe (*h*), and is supplied with a circular aperture (by which the liquid sulphur can be ladled out), usually kept closed by a moveable lid.

The *Stick, Roll, or Cane Sulphur* (*Sulphur in baculis; Sulphur in rotulis; Sulphur rotundum*) is refined sulphur which has been cast in wooden moulds.

Sublimed Sulphur (*Sulphur sublimatum*, L. D.), commonly termed *Flowers of Sulphur* (*Flores Sulphuris*), is apt to be contaminated with a little adhering acid (formed by the oxidation of sulphur), which, in both the Edinburgh and Dublin pharmacopœias, is ordered to be removed by washing.

The Edinburgh College orders *Sulphur sublimatum* to be thus prepared:—

"Sublime sulphur in a proper vessel; wash the powder thus obtained with boiling water in successive portions till the water ceases to have an acid taste; then dry the sulphur with a gentle heat."

The *Sulphur lotum* of the Dublin Pharmacopœia is prepared by pouring hot water on sublimed sulphur, and repeating the washing so long as the effused water appears contaminated with acid. This is discoverable by means of litmus. The sulphur is then to be dried on bibulous paper.

β. Decomposition of Metallic Sulphurets.—In some places sulphur is procured by the decomposition of metallic sulphurets (of iron and copper). In Anglesea, it is (or was) prepared by roasting copper pyrites, by which part of the sulphur is burned, while the remainder is volatilized and collected in chambers connected with the domes of the furnaces by means of horizontal flues[u].

The dregs remaining after the purification of sulphur are called *Horse Brimstone (Sulphur vivum; Sulphur caballinum; Sulphur griseum).*

PROPERTIES.—At common temperatures, pure sulphur is a brittle, crystallizable solid, of a yellowish-green colour, without smell, and with a very weak and almost imperceptible taste. Its specific gravity is about 1·99, but, when free from air-bubbles, 2·087. It is a bad conductor of electricity; and, therefore, by friction becomes powerfully electric. It is a bad conductor of heat, and when grasped in the warm hand, crackles, and sometimes breaks to pieces. It is fusible, volatilizable, and combustible. In atmospheric air it burns with a pale blue flame, and emits a large quantity of fumes having a peculiar suffocating odour (*sulphurous acid*).

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[u] Aikin's *Dict. of Chem.* vol. ii.

It is called *dimorphous*, because it is capable of crystallizing in forms belonging to two systems of crystallization. Thus, crystals of native sulphur, and those deposited from solutions of sulphur, belong to the right prismatic system; while crystals obtained by fusion and slow cooling of sulphur are referrible to the oblique rhombic prismatic system. It is temperature which determines the form: crystals which are formed at a temperature below 232°, belong to the right prismatic system; on the other hand, those produced at 232°, belong to the oblique system.

When sulphur is heated to 340°, it becomes viscid; and, by increasing the heat, the viscidity increases, until the temperature arrives at between 400° and 500°. If, while in this state, it be suddenly cooled, as by throwing it into water, it remains quite soft, so that it may be drawn out into threads. The cause of this change, which seems to be merely physical, is not understood. The atomic weight of sulphur is about 16.

Characteristics.—Sulphur is easily distinguished from other bodies, by its colour, its fusibility, its volatility, and its burning with a blue flame, and the evolution of sulphurous acid gas, the odour of which can be easily recognized.

IMPURITIES.—Rough sulphur is always mixed with variable quantities of foreign substances. Vauquelin[u] distilled 200 grains, and obtained a residuum of 0·82, composed of silica, carbonate of lime, iron, bituminous charcoal, alumina, and magnesia, but the proportion of earthy matters is generally more considerable. Sulphur obtained from pyrites sometimes contains orpiment (*sesquisulphuret of arsenicum*). The purity of any specimen is determinable by dissolving it in oil of turpentine, which does not act on the foreign matters. It should be perfectly volatile.

At a temperature of 600° sublimed sulphur totally evaporates. When washed with water, it does not alter the colour of litmus. *Ph. Lond.*

Litmus detects the presence of any free acid (sulphurous or sulphuric acid).

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Sulphur does not appear to be injurious to vegetables, for seeds vegetate and produce thriving plants when sown in sulphur.

β. On Animals.—At the veterinary school of Lyons it was found that a pound of sulphur killed horses by producing violent inflammation, recognizable during life by the symptoms, and after death by the morbid appearances[w].

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[u] *Ann. de Chim.* 25, 50.

γ. *On Man.*—In *small* and *repeated doses* sulphur acts as a gentle stimulant to the secreting organs, especially to the skin and the mucous membranes, particularly the bronchial membrane. It promotes the capillary circulation of these parts, and increases their secretions. Sundelin[x] says it operates specifically on the mucous membrane of the rectum, and thereby promotes critical hemorrhoidal secretions. That it becomes absorbed is shewn by the odour of hydrosulphuric acid which it communicates to the sweat, urine, and milk, and by silver articles becoming blackened in the pockets of patients who are under the influence of it. By the German physicians it is called a resolvent, and is ranked with the mercurial and antimonial preparations.[y] "From mercurial and antimonial medicines," says Sundelin, "sulphur is distinguished by its great diffusibility: in virtue of which it approximates to the exciting tonic agents; and also by its not possessing the liquefacient properties of these agents."

In *larger doses* (as one or two drachms) sulphur acts as a mild purgative, without exciting the pulse or occasioning griping. As the stools are usually solid, Dr. Paris[yy] concludes that the action of sulphur on the bowels is confined to the muscular coat.

Uses.—Sulphur is employed both internally and externally.

α. *Internally.*—It is given for various purposes. *In affections of the rectum,* as stricture, hemorrhoids, and prolapsus, it is a valuable agent as a mild purgative. I have frequently employed it in these cases as a substitute for castor oil. In order to promote its purgative effect, it will be sometimes necessary to conjoin magnesia or the bitartrate of potash. *In chronic cutaneous diseases,* more especially prurigo, impetigo, and scabies, the internal use of sulphur is sometimes attended with great benefit. *In pulmonary affections,* as chronic catarrhs and asthma, it is said to be sometimes useful. *In rheumatic and gouty affections* also. After an attack of acute rheumatism, when the joints are left in a swollen and painful state, I have seen sulphur prove highly useful. It is popularly taken with ardent spirit in this complaint. It has been employed as an *anthelmintic.* Vogt employs it as a *resolvent* in inflammation: as in croup, bronchitis, peripneumonia, and abdominal inflammation. In some constitutional diseases (as scrofula and secondary syphilis) it has been used as an *alterative.* Tortual has proposed sulphur as a preservative against measles: but, as might be expected, experience shews sulphur possesses no prophylactic power of this kind, and that the only preservative is isolation.

β. *Externally.*—Sulphur is a most valuable remedy in various skin diseases, more especially *scabies;* and notwithstanding many substitutes have been proposed for it in the latter disease, none are so generally successful. It is supposed by some that its curative powers in this disease depend on its poisonous influence over the so-called *itch-insect* (*Sarcoptes Hominis* of Raspail, the *Acarus Scabiei* of other writers): a little parasite belonging to the class *Arachnida* of articulated animals, and, therefore, improperly termed an *insect*[z].

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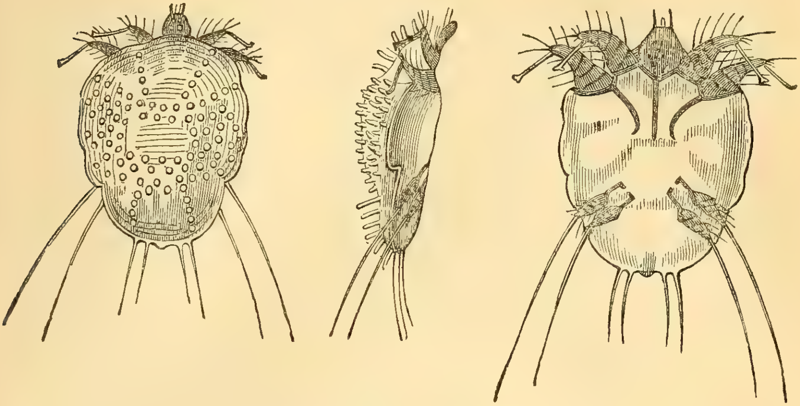
[w] Christison's *Treatise on Poisons.*

[x] *Heilmittell.* Bd. 1, S. 196.

[y] See p. 196.

[yy] *Pharmacologia,* vol. i. art. *Cathartics.*

FIG. 73.



Sarcoptes Hominis—(Raspail.)

But before adopting this explanation of the *modus medendi* of sulphur, it is to be proved that the animal is the *cause* of the disease; for, at present, it has not been satisfactorily shown whether it be the cause, effect, or mere accompaniment of itch. Rayer[a] observes, that it is indubitable that the number of these insects bears no proportion to that of the vesicles. "It is, further," he adds, "rare to discover these insects on the abdomen and on groins, where the eruption of scabies is nevertheless very common and very apparent; moreover, scabies is known to continue when no more acari are to be discovered." Sulphur is also a most valuable application in various other skin diseases, as porrigo, impetigo, &c.

ADMINISTRATION.—Internally, it is usually given with syrup, or treacle, in the form of an electuary, or suspended in milk. The dose of it, as a purgative, is from one to three or four drachms. As an alterative and sudorific, the dose is about half a drachm.

1. **UNGUENTUM SULPHURIS**, L. E. D. *Sulphur or Brimstone Ointment.* (Sulphur [sublimed] ℥iij. [℥j., *E.*; lbj., *D.*]; Hog's lard, lbss. [℥iv., *E.*; lbiv., *D.*] Mix them thoroughly together.—The *London College* adds of Oil of Bergamot, ♏xx.) Extensively employed in scabies, porrigo, and other skin diseases. In scabies, it is to be applied every night until the disease is cured.

2. **UNGUENTUM SULPHURIS COMPOSITUM**, *L. Compound Sulphur Ointment.*—(Sulphur, lbss.; White Hellebore, powdered, ℥ij.; Ni-

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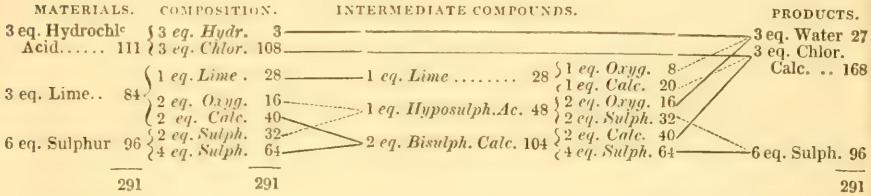
[z] Raspail, *Mémoire sur l'Insecte de la Gale.* Paris, 1834.
[a] *Treatise on Diseases of the Skin*, by Dr. Willis, p. 344.

trate of Potash, ℥j.; Soft Soap, lbss.; Lard, lbjss.; Oil of Bergamot, ♏xxx. Mix.) This is employed in the same cases as the preceding preparation, than which it is considered more efficacious, but at the same time more irritating.

3. SULPHUR PRÆCIPITATUM; *Precipitated Sulphur; Lac Sulphuris* or *Milk of Sulphur*.—This preparation was known to Geber[b]. It is prepared by boiling together sublimed Sulphur, one part; Slacked Lime, two parts; and Water eight parts. To the filtered solution is to be added a sufficient quantity of Hydrochloric Acid to precipitate the whole of the sulphur, which is collected and dried in a stove.

The *theory* of the process is the following:—When sulphur and lime are boiled in water, six equivalents or 96 parts of sulphur react on three equivalents or 84 parts of lime, and produce two equivalents or 104 parts of bisulphuret of calcium, and one equivalent or 76 parts of the hyposulphite of lime. By the action of three equivalents or 111 parts of hydrochloric acid on these two salts, we obtain three equivalents or 168 parts of chloride of calcium, six equivalents or 96 parts of sulphur, and three equivalents or 27 parts of water.



Precipitated sulphur agrees in most of its properties with sublimed sulphur, but is much whiter, and is in a finely pulverulent form. Berzelius says, that when melted, it gives out a little sulphuretted hydrogen; and on cooling, resumes the yellow colour it had before it was boiled with the alkali. H. Rose[bb] ascribes the whiteness of precipitated sulphur to its containing sulphuretted hydrogen in the state of persulphuret of hydrogen.

It is composed of sulphur with a little water; and hence it is frequently termed *hydrate of sulphur*. According to Bucholz, however, when well dried, it contains hardly a trace of water, and, therefore, that which, under ordinary circumstances, is contained in it, must be regarded as hygroscopic; so that the term *hydrate* is not strictly applicable to it.

On account of the extensive adulteration of this preparation, it has been omitted from all the British pharmacopœias. In the preparation of nearly the whole of the precipitated sulphur of the shops, sulphuric acid is substituted for hydrochloric acid, by which the product contains about two-thirds of its weight of sulphate of lime. Mr. Schweitzer[c] analyzed a sample, and found its composition to be as follows:—

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[b] *Invention of Verity*, chap. vi.

[bb] Poggendorf's *Annalen*, xlvii.; also, *Pharm. Central-Blatt. für* 1839, S. 441.

Sulphate of Lime	50
Water of Crystallization of ditto	13·1
Sulphur	36·9
Lac Sulphuris of the shops	100·0

I was informed by an extensive manufacturer of this article, that he prepares both kinds, the pure and the adulterated, and that the firm of Messrs. Barry and Co. is almost the only one which buys the pure kind. The adulteration is readily detected by subjecting the suspected preparation to heat in a crucible or on a fire shovel, when the sulphur and water of crystallization are volatilized, leaving behind the sulphate of lime. Or the sulphur may be dissolved out by oil of turpentine or liquor potassæ.

The effects, uses, and doses of this preparation, are the same as those of sublimed sulphur.

4. OLEUM SULPHURATUM; *Sulphurated Oil; Balsamum Sulphuris*, or *Balsam of Sulphur*. In the London Pharmacopœia for 1824, this compound was ordered to be prepared by dissolving one part of Sublimed Sulphur in eight parts of Olive Oil. The compound thus procured cannot be regarded as a mere solution of sulphur in oil, since the odour of hydrosulphuric acid, which it possesses, proves that the oil has undergone partial decomposition: in fact, the heat to which the oil is raised in order to boil it, causes a chemical change.

It is a dark reddish-brown viscid substance, having an extremely unpleasant odour. Its local action is that of an acrid: its remote operation that of a stimulant, causing thirst and febrile heat. It has been supposed to possess expectorant and diaphoretic properties. It is applied to foul ulcers, and is employed internally in chronic pulmonary affections. The dose of it is from 40 to 50 drops: but its unpleasant taste and smell almost preclude its use.

2. AC'IDUM SULPHU'RICUM, *L. E. D.*—SULPHURIC ACID.

History.—This acid appears to have been known to Geber as early as the seventh century[d]. In the state in which we usually meet with it in English commerce, it is usually denominated *Oil of Vitriol.*

Natural History.—It is found in both kingdoms of nature.

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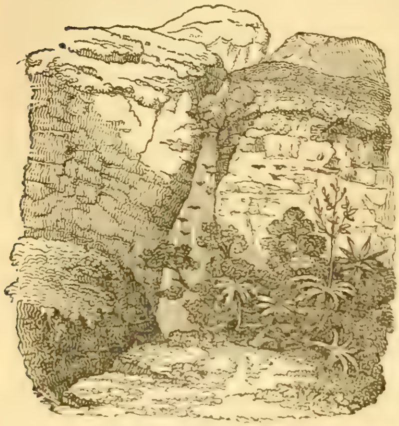
[c] *British Annals of Medicine*, vol. i. p. 618.
[d] Thomson's *Syst. of Inorg. Chem.* vol. ii. p. 29.

α. In the Inorganised Kingdom.—It is found in the waters of some volcanic regions, and is evidently produced by the combustion of sulphur. The *Rio Vinagre* (Vinegar River), which descends from the volcano of Puracé, in Colombia, to Popayan, has received its name from its acid properties, which it derives from being impregnated with sulphuric and hydrochloric acids[e].

Fig. 74.



Cascade of Vinagre in Colombia.

Issuing from the crater of Mont Ida, in Java, is a river which also contains this acid. Dr. Thomas Thomson[f] states, that in Persia there is an earth so strongly impregnated with it, that it is used by the natives as an acidulous seasoner of food. This author also says[g], that there are no less than twenty-seven sulphates (consisting of combinations of sulphuric acid with one or more bases) in the mineral kingdom. The most abundant of these is the sulphate of lime. The *Sour Springs* of Byron, Genesse county, ten miles south of the Erie canal, contain pure sulphuric acid[h].

β. In the Organised Kingdom.—The sulphates of lime, potash, and soda, have been found in plants[i]. The sulphates of potash and soda are mentioned by Berzelius[j] as constituents of human urine.

Preparation.—The most improved method of manufacturing oil of vitriol adopted in this country, is the following:—Crude sulphur is burned on a stone hearth or iron plate in a furnace (or *burner*), and the gas (sulphurous acid) thereby produced, is conveyed by a pipe or chimney into a leaden chamber, the bottom of which is covered to the extent of four or five inches with water. The furnace door has two apertures to regulate the supply of atmospheric air. After combustion has continued for several hours, an iron pot or pan, containing a mixture of the nitrate of potash or soda and oil of vitriol, is introduced into the furnace, and steam is conveyed into the leaden chamber[k]. So that sulphurous acid, nitric or nitrous acid (generated by the action of the oil of vitriol on the nitrate of potash, and volatilized by the heat produced by the combustion of the sulphur), and steam, are conveyed into the leaden chamber, and by their mutual reaction produce sulphuric acid, which is absorbed by the water at the bottom of the chamber. To prevent loss in the process, the residual gases are conveyed through two or more leaden chambers of unequal size (also containing water) before they are allowed to escape into the air. In one manufactory which I inspected, the chambers communicated with each other through a double-necked stone bottle, at the bottom of which was water.

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[e] A. de Humboldt, *Vues des Cordillères*, p. 220.

[f] *Mineralogy*, vol. i. p. 75.

[g] *Op. cit.* p. 77.

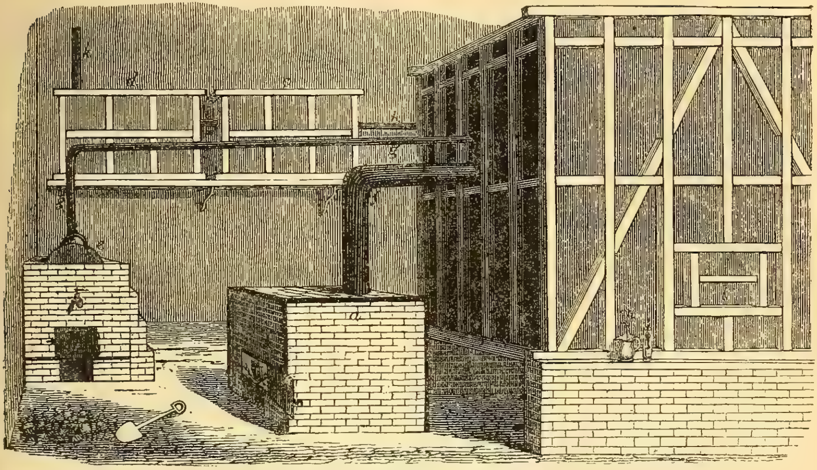
[h] Eaton, *Quarterly Journal of Science*, 1829, p. 200.

[i] De Candolle, *Phys. Végét.* p. 390.

[j] *Traité de Chim.* t. 7me, p. 393.

[k] Mr. Graham states, that sulphurous acid, nitric acid vapour, and steam, are simultaneously admitted into the leaden chamber; but in the manufactory of which fig. 75 is a sketch, the process followed is that described in the text.

FIG. 75.

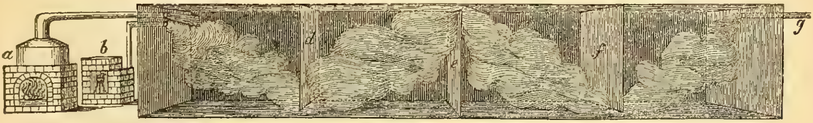


Oil of Vitriol Manufactory.

- *a.* Furnace.
- *b.* First leaden chamber.—In the manufactory from which the above sketch was made, this chamber was 70 feet long, 20 feet wide, and 20 feet high; but the size varies considerably in different establishments.
- *c.* Second ditto.
- *d.* Third ditto.
- *e.* Steam boiler.
- *f.* Pipe or chimney of the furnace.
- *g.* Steam pipe.
- *h.* Pipe conveying the residual gas from the first to the second leaden chamber.
- *i.* Pipe conveying the gas not absorbed in the first and second chambers into the third.
- *k.* Waste pipe conveying the unabsorbed gas into the atmosphere.
- *l.* Man-hole, by which the workmen enter the chamber when the process is not going on.
- *m.* Pipe for withdrawing a small portion of sulphuric acid from the chamber, in order to ascertain its sp. gr. by the hydrometer.

The leaden chamber is sometimes divided into two or three compartments by leaden curtains placed across it, as shown in the following cut taken from Professor Graham's *Elements of Chemistry*, vol. i. p. 324.

FIG. 76.



Oil of Vitriol Chamber.

- *a.* Steam Boiler.
- *b.* Section of Furnace or Burner.
- *d.* and *f.* Leaden curtains suspended from the roof of the chamber to within 6 inches of the floor.
- *e.* Leaden curtain rising from the floor to within 6 inches of the roof.
- *g.* Leaden conduit or vent tube for the discharge of uncondensible gases. It should communicate with a tall chimney to carry off these gases, and to occasion a slight draught in the chimney.

These curtains "serve to detain the vapours, and cause them to advance in a gradual manner through the chamber, so that the sulphuric acid is deposited as completely as possible, before the vapours reach the discharge tube."

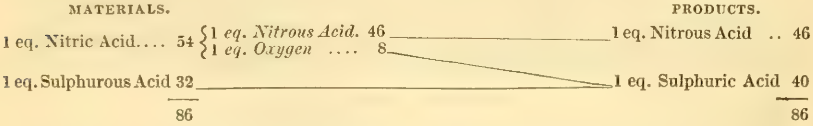
To check the combustion of the sulphur, it is sometimes mixed with some earthy matter, and made into truncated pyramidal masses, which are burnt in the usual way.

Since the high price of native sulphur, manufacturers have employed iron pyrites to yield sulphuric acid. I have seen pyrites from Wicklow, Cornwall, and St. Lucia, used for this purpose. The furnace for the combustion of it requires bars, to allow a greater supply of air. The sulphuric acid obtained from pyrites is usually contaminated with arsenious acid.

At Mr. Farmer's oil of vitriol manufactory, Kennington Common, I witnessed the escape of brown vapour (nitrous acid) from the vent pipe of the leaden chamber; and I was informed this was usual. It is evident, therefore, that the nitric acid is not completely deoxidized.

A crystalline matter is sometimes deposited in the pipes connected with the leaden chambers. It indicates a deficiency of water in the process. When the liquid in the leaden chamber has acquired a sp. gr. of about 1·5 (1·6 or 1·7, according to Mr. Farmer's statement to me), it is conveyed by leaden pipes into rectangular leaden boilers, where it is evaporated and concentrated until its sp. gr. is 1·70 (1·75, Farmer); but in some manufactories this part of the process is omitted. The final concentration is effected by boiling it down in *glass or platinum retorts:* the latter, notwithstanding their great cost, are now usually adopted. Their price, of course, depends on their size. Mr. Parkes[m] had one which held thirty gallons, and cost about £360; but sometimes they are made so large, that they are worth £1000 each. In this apparatus the acid is deprived of a part of its water and some sulphurous acid, and when it has attained a sufficient degree of concentration, it is drawn off by means of a platinum syphon into carboys.

The *theory* of the process is the following;—When sulphurous acid gas, nitric acid vapour, and aqueous vapour, come into contact with each other, the sulphurous acid robs the nitric acid of part of its oxygen, and is thereby converted into sulphuric acid. By this partial deoxidation, nitric acid is converted into nitrous acid.



The nitrous acid thus produced is further deoxidized and converted into binoxide of nitrogen, by another portion of sulphurous acid, which, thus gaining oxygen, is converted into sulphuric acid. If there be excess of nitrous acid and a deficiency of water, a crystalline matter[n] is sometimes deposited. Its formation depends on the sulphuric acid first formed, decomposing some nitrous acid into nitric acid and binoxide of nitrogen: with the latter the sulphuric acid combines to form the crystalline compound. Hence to prevent its production excess of sulphurous acid and water should be present.

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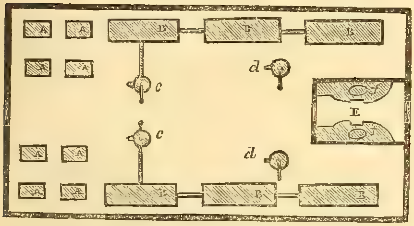
[m] *Chem. Essays,* vol. i. p. 535.

An interesting illustration of the above reactions is obtained by generating sulphurous acid in a flask, and conveying the gas, by means of a curved glass tube, into a tall jar, at the bottom of which is a small quantity of colourless but concentrated nitric acid. Brown vapours of nitrous acid are evolved, sulphuric acid is formed, and the jar becomes lined with a crystalline matter, which dissolves with effervescence in water.

The old method of manufacturing oil of vitriol, and, indeed, one still followed in some places, consists in burning a mixture of eight parts of sulphur and one part of nitrate of potash (or nitrate of soda) on iron or leaden plates, either within the leaden chamber or in a furnace on the outside of it[o]. Fig. 77 is the ground plan of a manufactory of this kind.

Fig. 77.



Plan of a Sulphuric Acid Manufactory.

A, Rectangular leaden boilers.
B, Leaden chambers.
E, Retort house.
c, Leaden pump for acid.
d, Water pump.

In this process an equivalent of sulphur combines with two equivalents of atmospheric oxygen to form one equivalent of sulphurous acid. Another equivalent of sulphur abstracts three equivalents of oxygen from one equivalent of nitric acid of the nitrate, and thereby becomes sulphuric acid, which, with the potash of the nitre, forms an equivalent of sulphate of potash. One equivalent of binoxide of nitrogen is evolved by the decomposed nitric acid, and this, combining with two equivalents of atmospheric oxygen, becomes nitrous acid, which, aided by the presence of water, reacts on a further portion of sulphurous acid.

At Goslar, Nordhausen, and other parts of Saxony, sulphuric acid is made thus:—Crystallized sulphate of iron is calcined, by which the greater portion of its water of crystallization is expelled. It is then distilled in earthen vessels, by which *fuming sulphuric acid* is procured, while sesquioxide of iron is left in the retort. If this acid be heated in a glass retort, real or anhydrous sulphuric acid distils over.

PROPERTIES. *α.* **Of Anhydrous Sulphuric Acid.**—It is a white crystalline solid, having very much the appearance of asbestos. Exposed to the air it attracts water, and flies off in the form of dense white fumes. It melts at 66° F., and boils at from 104° to 122° F. The sp. gr. of the liquid acid, at 78° F. is 1·97. It does not redden litmus unless moisture be present.

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[n] Much difference of opinion has existed with respect to the nature of the crystalline matter which is occasionally formed in the leaden chamber of the sulphuric acid manufacturer. Davy (*Elements of Chemical Philosophy*, p. 276, 1812) regarded it as a compound of *water, nitrous acid*, and *sulphurous acid*. Dr. W. Henry (*Annals of Philosophy*, N.S. xi. p. 368), and afterwards Gaultier de Claubry (*Ann. de Chim. et Phys.* t. xlv. p. 284) submitted it to analysis. The latter found its constituents to be *anhydrous sulphuric acid* 65·59, *hyponitrous acid* 23·96, and *water* 10·10. In 1839 Henrich Rose (*Pharm. Central-Blatt für* 1839, S. 664) described a solid compound of *anhydrous sulphuric acid* and *binoxide of nitrogen* ($2SO^3 + NO^2$). Adolphe Rose (Ibid. *für* 1840, S. 481; also *Journ. de Pharm.* t. xxvii. p. 138) has shown that the crystals which form in the leaden chamber consist of *sulphuric acid, binoxide of nitrogen*, and *water*. M. Provostaye (*Journ. de Pharm.* t. xxvi. p. 637) has also examined this crystalline matter.

[o] Parkes's *Chemical Essays*, vol. i. 465.

Its composition is as follows:—

	Atoms.	*Eq.Wt.*	*Per Ct.*	*Berzelius.*		*Vol.*
Sulphur	1	16	40	40·14	Sulphurous acid gas	1
Oxygen	3	24	60	59·86	Oxygen gas	0·5
Anhydrous Sulphuric acid	1	40	100	100·00	Sulphuric acid vapour	1?

β. **Of Nordhausen or Fuming Sulphuric Acid.**—This is usually a dark brown, oily liquid, which gives out copious white fumes in the air. Its sp. gr. is about 1·9. It is imported in stone bottles, having a stoneware screw for a stopper. When subjected to heat, it gives out the vapour of anhydrous sulphuric acid: the residue in the retort resembles oil of vitriol. The composition of fuming sulphuric acid is as follows:—

	Atoms.	*Eq.Wt.*	*Per Ct.*			*Atoms.*	*Eq.Wt.*
Anhydrous Sulphuric Acid	2	80	89·88	or	Anhydrous Sulphuric Acid	1	40
Water	1	9	10·11		Protohydrate Sulphuric Acid	1	49
Fuming Sulphuric Acid	1	89	99·99			1	89

γ. **Of Oil of Vitriol, or English Sulphuric Acid.** (*Acidum Sulphuricum*, L. E. *Acidum Sulphuricum venale*, D.).—This is a colourless, transparent, inodorous, highly acrid, and corrosive liquid. It possesses the usual properties of a powerful mineral acid in a very eminent degree, such as reddening the vegetable blues, saturating bases, and displacing other acids. Its affinity for water is most intense, and by virtue of this, it absorbs aqueous vapour from the atmosphere, and chars animal and vegetable substances. When mixed with water there is a mutual condensation with the evolution of heat. Various substances when heated in sulphuric acid decompose it; they abstract oxygen and evolve sulphurous acid. This is the case with charcoal, organic substances, phosphorus, sulphur, and several of the metals, as copper, tin, and mercury.

The sp. gr. of this acid at 60° F. is about 1·84. Genuine *commercial* acid should never surpass 1·8455; when it is denser, we may infer sophistication or negligence in the manufacture[p].

According to the *London College*, good oil of vitriol possesses the following characters:—

It is free from colour. Its specific gravity is 1·845. What remains after the acid has been distilled to dryness, does not exceed the four-hundredth part of its weight. Diluted sulphuric acid is scarcely coloured by hydrosulphuric acid.

The *Edinburgh College* gives the following characters of it:—

"Density 1840, or near it: colourless: when diluted with its own volume of water only a scanty muddiness arises, and no orange fumes escape."

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[p] Brande's *Manual of Chemistry*, 5th edit. 1841.

The "muddiness" here referred to depends on the precipitation of sulphate of lead, which commercial oil of vitriol usually holds in solution, but which is deposited when water is added. The "orange fumes" are nitrous acid vapour.

The *Dublin College* states the sp. gr. of commercial sulphuric acid to be 1·850; but this is erroneous. It ought not to exceed 1·845.

In order to procure *Pure Oil of Vitriol (Acidum Sulphuricum purum*, E. D.), both the Edinburgh and Dublin Colleges give directions for the purification of the commercial acid.

The *Edinburgh College* states, that "if commercial sulphuric acid contain nitrous acid, heat eight fluidounces of it with between ten and fifteen grains of sugar, at a temperature not quite sufficient to boil the acid, till the dark colour at first produced shall have nearly or altogether disappeared. This process removes nitrous acid. Other impurities may be removed by distillation; which, on the small scale, is easily managed by boiling the acid with a few platinum chips in a glass retort by means of a sand-bath or gas-flame,—rejecting the first half ounce." The College gives the following characters of the pure acid:—"Density, 1845: colourless: dilution causes no muddiness: solution of sulphate of iron shows no reddening at the line of contact when poured over it."

The *Dublin College* orders of Commercial Sulphuric Acid, lbj. Pass the acid into a retort of flint glass, attach a receiver of the same kind, and with the junctures of the vessels left open, let heat be applied to the retort until one-twelfth part of the liquor shall have distilled over; this, as it contains water, should be rejected. The receiver being again applied, the residuum is to be redistilled to dryness. A few slips of platina passed into the acid in the retort will restrain the ebullition, which otherwise would be too violent. The specific gravity of this acid is to the specific gravity of distilled water as 1845 to 1000. Let this acid be kept in well-closed vessels.

COMPOSITION.—The composition of oil of vitriol or English sulphuric acid is as follows:—

	Strongest (sp. gr. 1·845).			Commercial (sp. gr. 1·8433).		
	Atoms.	*Eq. Wt*	*Per Cent.*	*Atoms.*	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	81·6	1	40	78
Water	1	9	18·4	1¼	11·25	22
Oil of Vitriol	1	49	100·0	1	51·25	100

Characteristics.—Free sulphuric acid or the soluble sulphates are recognized by a solution of any of the barytic salts, which throws down a heavy white precipitate (*sulphate of baryta*) insoluble in acids or alkalis. If this precipitate be ignited with charcoal, it is decomposed and converted into sulphuret of barium, which, on the addition of hydrochloric acid, evolves hydrosulphuric acid, known by its odour and its blackening paper moistened with acetate of lead. If sulphuric acid be heated with organic matter, sulphurous acid is given out: this may be known by its odour, and by its occasioning the formation of the blue iodide of starch, when mixed with iodic acid and starch. Oil of vitriol is reddened by veratria, salicin, piperin, oil of bitter almonds, phloridzine, &c.

To determine whether sulphuric acid be free or combined with a base, Dr. Christison[q] recommends the liquid to be boiled with pure carbonate of lead. If free sulphuric acid be present sulphate of lead will be formed, which, being insoluble in dilute nitric acid, may be thereby distinguished from carbonate of lead; and it is assumed that no sulphate of lead will be formed if there is only a natural sulphate present, "because carbonate of lead and the neutral sulphates do not decompose each other." But this test is liable to objection: alum, sal enixum, sesquisulphate of iron, and other supersulphates, re-act on carbonate of lead like free sulphuric acid; and, furthermore, neutral sulphate of ammonia is decomposed at a boiling temperature by carbonate of lead.

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[q] *Treatise on Poisons*, 3d ed. p. 142.

IMPURITIES.—Pure oil of vitriol should be colourless: the presence of *organic matter*, as cork, communicates a brownish or black colour. The acid of commerce usually contains traces of *sulphate of lead:* this may be detected either by adding water, when the white sulphate is precipitated; or by the addition of hydrosulphuric acid to the dilute sulphuric acid, when a very slight change of colour is observed, owing to the formation of sulphuret of lead. "What remains [*i. e.* sulphate of lead] after the acid has been distilled to dryness does not exceed the $\frac{1}{400}$ part of its weight."

Oil of vitriol frequently, or usually, contains an *oxide of nitrogen.* According to A. Rose it is generally the binoxide of nitrogen. A solution of the protosulphate of iron detects the binoxide of nitrogen, nitrous acid, or nitric acid, by the reddish brown or brownish black colour which it gives rise to, "if a sufficient quantity of pure sulphuric acid be added to the liquid to be examined" (A. Rose). Permanganate of potash is an excellent test of binoxide of nitrogen or nitrous acid in sulphuric acid, diluted with about six parts of water. If either of these substances be present, the permanganate is decolorized. This effect is not produced by the presence of pure nitric acid in diluted sulphuric acid. Hence it distinguishes binoxide of nitrogen and nitrous acid from nitric acid.

Latterly, in consequence of the high price of Sicilian sulphur, sulphuric acid has been extensively manufactured from iron pyrites, in which arsenic is usually contained; and in consequence the oil of vitriol of commerce has been found to be contaminated with *arsenious acid.* Dr. G. O. Rees[r] found 22·58 grains of this acid in twenty fluidounces of oil of vitriol; and Mr. Watson[s] states that the smallest quantity which he has detected is 35½ grains in twenty fluidounces. The tests for this dangerous contamination are Marsh's test and sulphuretted hydrogen[t]. In the application of these the acid must be previously diluted with distilled water.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—In the concentrated state sulphuric acid chars the parts of plants to which it is applied. In the dilute form it destroys vegetables in a few hours[u].

β. *On Animals generally.*—The action of sulphuric acid on animals generally is precisely the same as that on man. Thrown into the veins of a dog, Orfila found that it coagulated the blood, and caused immediate death[v].

γ. *On Man.*—Properly diluted, and administered in small but repeated doses, sulphuric acid acts like the other mineral acids (see pp. 189, 193, 201, and 212). Thus it promotes the appetite, diminishes febrile heat, allays excessive thirst, checks profuse sweating, and, not unfrequently, reduces the frequency of the pulse. Sometimes it increases the secretion of urine, and likewise renders this fluid unusually acid. Under its use the milk frequently acquires a griping quality.

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[r] *London Medical Gazette* for Feb. 5, 1841.

[s] *Ibid.* for Feb. 1841. Mr. Watson states that a man had nearly lost his life in consequence of the inhalation of arseniuretted hydrogen, produced in the manufacture of hydrochloric acid, by the diluted, unpurified, pyrites sulphuric acid acting upon the iron retort employed.

[t] See the article *Arsenious Acid,* in a subsequent part of this work, where full directions will be given for the application of these tests.

[u] Marcet, in De Candolle's *Phys. Végét.* p. 1345.

[v] *Toxicologie Générale.*

The continued use of it, however, generates a slow kind of gastroenteritis: heat and pain are experienced in the throat, stomach, and intestines: the digestive functions become disordered; gripings are experienced; sometimes purging, and subsequently fever. Of all the mineral acids, save the phosphoric, this may be administered for the longest period without occasioning the above symptoms.

Concentrated sulphuric acid acts as an energetic caustic poison, promptly disorganizing the different tissues with which it is brought into contact. Its chemical action depends principally on its affinity for water, so that it chars or carbonizes the parts with which it is placed in contact. But its power of coagulating albuminous liquids, of combining with albumen to form a sulphate of this organic substance, and of dissolving fibrin, as well as coagulated albumen, contributes to its energetic escharotic action on the animal tissues. The parts to which the acid is applied become, in the first place, white by the formation of sulphate of albumen. This effect is seen both in the skin and the cornea. By the more prolonged action of the poison, they assume a brownish or blackish appearance, so that we can thereby frequently distinguish poisoning by this from poisoning by nitric acid; since this last-mentioned agent produces a yellow colour when applied to the skin. Black spots are frequently observed in the stomachs of those who have swallowed the acid; and in the surrounding parts the blood is usually coagulated in the blood-vessels. Such are the topical chemical effects of this acid. But besides these there are other phenomena of a local nature which may be denominated vital, since they depend on the re-action of the living parts. I refer now to those indicating the production of inflammation in the tissues in the immediate neighbourhood of those destroyed.

When strong sulphuric acid has been swallowed, the symptoms of poisoning are the following:—Alteration, or even destruction, of the soft parts about the mouth; burning pain in the throat, stomach, and bowels; frequently alteration of the voice, from the swelling and disorganization of the parts about the larynx; breath fetid, from the decomposed tissues; constant and abundant vomiting of matters, which may be bloody or otherwise, but which effervesce by falling on a marble hearth; bowels variously affected, sometimes constipated, though usually purged, the stools being bloody. The constitutional symptoms are principally those arising from a disordered action of the vascular system: thus the pulse is frequent and irregular, feeble, often imperceptible; extremities cold; great feebleness, or even fainting, with cold sweats. The same constitutional symptoms are observed when the stomach is wounded or ruptured. One remarkable characteristic is, that the mental faculties are unaffected, even up to a few minutes before death.

Not unfrequently the acid fails to produce speedy death from corrosion and inflammation, but gives rise to a peculiar organic disease of the stomach and intestines, of which the patient slowly dies, sometimes after several months' suffering[w].

USES.—Sulphuric acid, properly diluted, may be administered in *febrile diseases*, as a refrigerant, to diminish thirst and preternatural heat; though, in most of these cases, the vegetable acids are to be preferred. In the latter stage of fever (especially the kinds called typhoid) considerable benefit is sometimes gained by the use of a vegetable bitter (as calumba or cinchona) in combination with the diluted sulphuric acid. To assist the appetite and promote digestion, it is administered to patients recovering from fever. *To check profuse sweating* in pulmonary and other affections, whether phthisical or not, it is sometimes a valuable agent, as I have found on many occasions. No other remedy is so efficacious in relieving colliquative sweatings as this. In *hemorrhages*, as those from the nose, lungs, stomach, and uterus, it is commonly administered as an astringent, but its efficacy is doubtful. So also in purpura hæmorrhagica it is given with the same intention; but though I have several times employed it, I have not observed any evident benefit derived therefrom. In those forms of *lithiasis* attended with phosphatic sediments in the urine, the use of the mineral acids is at times beneficial. The sulphuric is preferred to the hydrochloric acid, since it can be continued for a longer period without occasioning gastric disorder. In *skin diseases*, especially lichen, prurigo, and chronic nettle-rash, it is sometimes serviceable. No remedy is so successful in relieving the distressing itching, formication, and tingling of the skin, as diluted sulphuric acid taken internally. In those forms of *dyspepsia* connected with an alkaline condition of the stomach, as in pyrosis, the sulphuric has been found to succeed better than hydrochloric acid[x].

As a local agent, sulphuric acid is employed as a caustic, irritant, or astringent. As a caustic it has no advantage over many other agents, except that which arises from its liquid form, which, in most cases, renders it disadvantageous. For example, the difficulty of localizing it would be an objection to its employment in the production of an issue, but would be an advantage in applying it to wounds caused by rabid animals or poisonous serpents, since the liquidity of the acid enables it to penetrate into all parts of the bites. In entropium, or that disease in which the eyelid is inverted, or turned inwards upon the eye, this acid has been applied as a caustic. In this complaint the friction of the eyelashes on the globe is most distressing, giving rise not only to inflammation, but even ulceration of the cornea. Now, when the disease is permanent, two modes of curing it have been proposed; either to remove a fold of the integument by the knife, so that, by the subsequent cicatrization, the lid may be drawn outwards—or to destroy a portion of the skin by a caustic, as sulphuric acid. The latter plan of treatment has been practised successfully by several eminent oculists, among whom I may name Mr. Guthrie and Mr. Lawrence. So also in ectropium, in which the lid is everted or turned outward, Mr. Guthrie has applied the concentrated acid to the inner side of the everted lid with advantage. An ointment containing sulphuric acid has been employed as a rubefacient in paralysis, and in the second stage of inflammation of the joints, when the violence of the disease has subsided ; as a styptic to wounds, to suppress hemorrhage from numerous small vessels; and as a cure for scabies. Lastly, this acid, properly diluted, is employed as an astringent gargle in ulcerations of the mouth and throat: but after using it the mouth should be well rinsed, to prevent the action of the acid on the teeth.

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[w] For further information respecting the topical action of sulphuric acid, the reader may consult (besides Dr. Christison's *Treatise on Poisons*) the observations of Dr. R. D. Thomson, in the *Athenæum* for 1840, pp. 779 and 798; also the *Lancet* for 1836-7, vol. i. p. 195; and Mr. Taylor, in *Guy's Hospital Reports*, vol. iv.

[x] Dr. R. D. Thomson, *British Annals of Med.* March 31, 1837.

ADMINISTRATION.—For internal use we generally make use of the *diluted sulphuric acid*, or the *elixir of vitriol.*

ANTIDOTES.—In cases of poisoning by sulphuric acid, the antidotes are chalk, whiting, or magnesia, suspended in water. In the absence of these, soap-suds, infusion of wood-ashes, weak solutions of the alkaline carbonates, white of eggs, gelatine, milk, oil, or in fact any mild diluent, should be immediately administered. The subsequent treatment is that for gastro-enteritis. External parts burnt with oil of vitriol should be washed with a solution of soap or simple water.

1. ACIDUM SULPHURICUM DILUTUM, L. E. D. *Diluted Sulphuric Acid; Spirit of Vitriol*, or *Spiritus Vitrioli tenuis; Vitriol to clean Copper.* (Sulphuric Acid, f℥iss. [f℥j. *E.*; one part, *D.*] ; Distilled Water, f℥xivss. [f℥xiij., *E.* ; seven parts, *D.*] Add the acid to the water gradually, and mix. When the acid and water are mixed, condensation ensues, and heat is evolved).—The white precipitate which forms is sulphate of lead. It is much to be regretted that the formulæ of the British colleges, for the preparation of this acid, should not have been uniform. The error which the Edinburgh College has fallen into, in consequence of this discrepancy, has been already[y] pointed out. Diluted sulphuric acid, prepared according to the directions of the London College, has a sp. gr. of about 1·11, and a fluidrachm of it, which weighs 60·7 grs., saturates 28 grains of crystallized carbonate of soda: hence it contains 9½ grains of strong oil of vitriol, or 7·7 grs. of anhydrous sulphuric acid, and its per-centage composition will be as follows:—

	By weight.		*By weight.*
Anhydrous Sulphuric Acid	12·8	Strongest Oil of Vitriol	15·7
Water	87·2	Water	84·3
Acidum Sulphuricum Dilutum, *Ph. L.*	100·0		100·0

The density of the Edinburgh diluted sulphuric acid is 1·090. The comparative strengths, by weight, of the Edinburgh and London preparations, are as 100 to 78: by volume the difference is still greater[z]. The dose of diluted sulphuric acid is from ♏x. to ♏xxx. or ♏xl., diluted with two or three table-spoonfuls of some mild liquid. A most convenient preparation of it is the *Compound Infusion of Roses*. It may also be exhibited in Conserve of Roses.

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[y] See pp. 405 and 410, oot-notes.

2. **ACIDUM SULPHURICUM AROMATICUM**, E. D. *Aromatic Sulphuric Acid; Elixir of Vitriol*, or *Acid Elixir of Vitriol.*—(" The *Edinburgh College* orders of Sulphuric Acid (commercial) fʒiiiss; Rectified Spirit, Oiss.; Cinnamon, in moderately fine powder, ℥iss.; Ginger, in moderately fine powder, ℥j. Add the acid gradually to the spirit; let the mixture digest at a very gentle heat for three days in a closed vessel; mix the powders, moisten them with a little of the acid spirit, let the mass rest for twelve hours, and then put it into a percolator, and transmit the rest of the acid spirit. This preparation may also be made by digesting the powders for six days in the acid spirit, and then straining the liquor.")——The *Dublin College* orders of Rectified Spirit Oij. [*wine measure*], Sulphuric Acid, *by weight*, ℥vj. Add the acid to the spirit gradually: digest the mixture in a closed vessel with an inferior heat, for three days; then add of Cinnamon bark, bruised, ℥iss.; Ginger root, bruised, ℥j. Digest the mixture again for six days; and, lastly, filter through paper placed in a glass funnel). When oil of vitriol and rectified spirit are digested together, bisulphate of the oxide of ethule (formerly called sulphovinic acid) is formed (see p. 370). The late Dr. Duncan, junior[a], ascertained " that not a particle of gas is evolved by the mixture of alcohol and sulphuric acid in the proportions indicated." It is employed as an agreeable substitute for the diluted sulphuric acid; and is administered in the same doses. In a case of poisoning by ten drachms of this preparation, the symptoms were those of local irritation, with vomiting and purging of blood. The patient recovered[b].

3. **UNGUENTUM ACIDI SULPHURICI**, D. *Sulphuric Acid Ointment.*—(Sulphuric Acid, ʒj.; Prepared Hog's Lard, ℥j. Mix). The ingredients should be mixed in a glass or earthenware mortar. The precise changes which sulphuric acid effects on lard have not been studied: they are most likely analogous to those effected by the acid on olive oil. The sulphuric acid probably unites on the one hand with the glycerine (oxide of glycerule) of the lard to form bisulphate of glycerine,—and on the other with the fatty acids (oleic, margaric (?) and stearic acids) of the lard. This ointment is of a buff colour. It is a powerful stimulant, and has been employed in paralysis, hemorrhages, and scabies, as before mentioned (see p. 472).

3. AC'IDUM SULPHURO'SUM.—SULPHUROUS ACID.

HISTORY.—Homer[c] mentions sulphur fumigations. Stahl, Scheele, and Priestley, were the first to submit this acid to an accurate examination. It has been termed *Volatile Sulphurous Acid*, and, from the old mode of procuring it, *Spirit of Sulphur by the Bell* (*Spiritus Sulphuris per Campanam*).

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[z] Mr. R. Phillips, *Lond. Med. Gaz.* Aug. 3, 1839, p. 689.
[a] *Supplement to the Edinburgh Dispensatory*, p. 175. Edinb. 1829.
[b] *Lond. Med. Gaz.* vol. xxv. p. 944.
[c] *Iliad*, xvi.

Natural History.—It escapes from the earth, in a gaseous form, in the neighbourhood of volcanoes.

Preparation.—For chemical purposes it is prepared by mixing two parts of mercury with three parts of strong sulphuric acid, applying heat, and collecting over mercury. The results are, the bipersulphate of mercury and sulphurous acid.

For medicinal purposes, however, it is rarely, if ever, necessary to procure it in this way. By the combustion of sulphur in atmospheric air this gas is readily obtained; and when we are about to employ it, either as a disinfectant or vapour bath, this method is always followed.

Properties. — At ordinary temperatures and pressures it is a colourless and transparent gas, and has a remarkable and well-known odour. It is neither combustible nor a supporter of combustion. It reddens litmus and bleaches some colouring matters, especially infusion of roses, but the colour is restored by sulphuric acid. It is irrespirable, and has a sp. gr. of 2·2. It readily dissolves in water: recently boiled water takes up 33 times its volume of this gas. By cold and pressure it is readily condensed into a limpid liquid.

Characteristics.—This acid is readily known by its peculiar odour (that of burning sulphur). If the puce-coloured or binoxide of lead be added to it, the white protosulphate of lead is formed. An aqueous solution of this acid, mixed with iodic acid, deoxidizes the latter, and sets iodine free, which may be recognized by its producing a blue colour with starch. A solution of an alkaline sulphite causes, with a soluble salt of barium, a white precipitate (*sulphite of baryta*). The sulphites evolve sulphurous acid by the action of strong sulphuric acid.

Constituents.		Resulting Compound.
2 eq. Oxygen = 16	and 1 eq. Sulphur = 16	1 eq. Sulphurous Acid = 32

Composition.—If 16 parts by weight of sulphur be burned in one volume or 16 parts (by weight) of oxygen gas, we obtain one volume or 32 parts (by weight) of sulphurous acid gas.

The composition of this substance may, therefore, be thus expressed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Sulphur	1	16	50	49·968
Oxygen	2	16	50	50·032
Sulphurous Acid	1	32	100	100·000

Physiological Effects. *α. On Vegetables.*—It is a most powerful poison to plants, even in very minute quantities[d].

β. On Animals generally.—The effects on animals have not been examined; but they are probably those of an irritant and asphyxiating agent.

γ. On Man.—Applied to the skin this acid gas causes heat, pain, and itching. If an attempt be made to inhale it in the pure state, it excites spasm of the glottis. Diluted with air it may be taken into the lungs, and there acts as a local irritant, causing cough, heat, and pain.

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[d] Christison, *On Poisons*, 3d ed. p. 750.

Uses.—It has been used as a disinfectant, as a remedy for the cure of itch, and as a nasal stimulant in syncope.

As a *disinfectant* it is mentioned by Homer. The mode of using it for this purpose is very simple. A pot containing burning sulphur is introduced into the room or place to be fumigated, and the doors and windows carefully closed.

As a remedy for itch, baths of sulphurous acid gas are mentioned by Glauber in 1659. They are commonly termed *sulphur baths*, and may be had at most of the bathing establishments of the principal towns of this country. At the Hôpital St.-Louis, in Paris, a very complete apparatus for the application of this remedy in diseases of the skin has been erected by D'Arcet[e]. It is a kind of box, inclosing the whole body, with the exception of the head. The sulphur is placed on a heated plate in the lower part of the box. From ten to twenty baths, or even more, are requisite for the cure of itch. "Sulphurous fumigations," says Rayer[f], "which are employed in some hospitals, are not attended with expense, leave no unpleasant smell, and do not soil the linen; but the long continuance of the treatment necessary to relieve the disease, more than counterbalances these generally insignificant recommendations." There are various other diseases of the skin in which baths of sulphurous acid have been found more or less successful, such as chronic eczema, lepra, psoriasis, impetigo, and pityriasis[g].

As a stimulant in syncope or asphyxia this gas has been recommended by Nysten. It is readily applied by holding a burning sulphur match under the nose.

Antidotes.—When sulphurous acid gas has been inhaled, the patient should be made to respire the vapour of ammonia. A few drops of the solution of this substance should be swallowed.

4. SUL'PHURIS IO'DIDUM.—IODIDE OF SULPHUR.

History.—This compound was first described by Gay-Lussac[h].

Preparation.—It is prepared by heating gently, in a clean oil flask, four parts of iodine with one part of sulphur until fusion is effected. Part of the iodine volatilizes, and the remainder unites with the sulphur.

Properties.—It is a black crystallizable compound, having the colour and radiated appearance of sesquisulphuret of antimony. It has the odour of iodine, and stains the cuticle, paper, &c. like this substance. Its elements are easily separated by heat.

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[e] *Description des Appareils à Fumigations établis sur ses Dessins à l'Hôpital Saint-Louis en* 1814, *et successivement dans plusieurs Hôpitaux de Paris, pour le Traitement des Maladies de la Peau.* Paris, 1818.

[f] *Treatise on Diseases of the Skin*, by Dr. Willis, p. 347.

[g] For further information on this subject consult *Mémoire et Rapports sur les Fumigations Sulfureuses*, par J. C. Galés, 1816; *Observations on Sulphurous Fumigations*, by W. Wallace; *An Essay on Diseases of the Skin*, by Sir A. Clarke.

[h] *Ann. de Chimie*, xci. 22. 1814.

Characteristics.—Boiled in water the iodine volatilizes with the steam, and the sulphur is deposited nearly in a state of purity.

COMPOSITION.—Its composition has not been determined. It is probably the following:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Iodine	1	126	79·75
Sulphur	2	32	20·25
Iodide of Sulphur	1	158	100·00

PHYSIOLOGICAL EFFECTS.—*α. On Animals.*—Dr. Cogswell[i] gave three drachms to a bitch: the animal lost her appetite, was dull, and on the fourth day could not support herself properly upon her legs. On the twelfth day she was well.

β. On Man.—It has not been exhibited internally. It probably operates like iodine. Its local operation is that of a powerful stimulant and resolvent.

USES.—Iodide of sulphur has been principally employed in the form of ointment, in various skin diseases. In *lupus* it has been found most efficacious by Biett[j], as well as Rayer[k]. The last mentioned writer places it in the foremost rank of local remedies for this disease. In *acne indurata* and *rosacea* it has proved highly useful in the hands of Biett[l], Rayer[m], and Dr. Copland[n]. In *lepra*, Rayer has observed good effects from its use; but in one case in which I tried it, it caused so much irritation that its use was obliged to be discontinued. In *herpes pustulosus labialis* it has been employed with great success by Dr. Volmar[o]. In *tinea capitis* it has also been recommended[p].

Dr. Copland[q] has employed the inhalation of the vapour of this substance in humoral asthma with temporary advantage.

UNGUENTUM SULPHURIS IODIDI; *Ointment of Iodide of Sulphur.*—This is composed of iodide of sulphur and lard. The proportions vary according to circumstances: usually from 10 to 30 grains of the iodide to an ounce of lard. Magendie recommends 1 part of iodide to 18 or 19 of lard.

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[i] *Experimental Essay on Iodine and its Compounds.*

[j] Cazenove and Schedel, *Abrégé pratiq. sur les Malad. de la Peau.*

[k] *Treatise on Diseases of the Skin*, translated by Dr. Willis.

[l] *Op. cit.*

[m] *Op. cit.* p. 476.

[n] *Dict. of Pract. Med.* art. *Acne*, p. 31.

[o] Dierbach, *Die neuesten Entdeck in d. Mat. Med.* 2e Ausg. 1er B. S. 449.

[p] *Lond. Med. Gaz.* vol. xx. p. 879.

[q] *Op. cit.* art. *Asthma*, p. 149.

5. AMMO'NIÆ HYDROSUL'PHAS.—HYDROSULPHATE OF AMMONIA.

(Ammoniæ Hydrosulphuretum, *D.*)

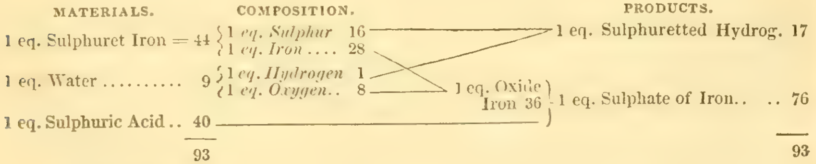
History and Synonymes.—This compound is said to have been first prepared in the seventeenth century by Boyle or Beguin: hence the terms *Boyle's fuming liquor* and *Beguin's sulphuretted spirit*, applied to one variety of it. The ordinary designation of it is *hydrosulphuret of ammonia*, or *hepatized ammonia*. Berzelius calls it *sulphuret of ammonia*.

Natural History.—It is evolved from decomposing animal matter (as in privies), along with hydrosulphuric acid and nitrogen.

Preparation.—The following are the directions given by the Dublin College for the preparation of this compound:—

> Take of Sulphuret of iron, reduced to a coarse powder, five parts; Sulphuric Acid, seven parts; Water, thirty-two parts; Water of Caustic Ammonia, four parts. Pass the sulphuret into a retort, then gradually pour on it the acid, first diluted with water, and, in a suitable apparatus, cause the elastic fluid to pass through the Water of Ammonia. Toward the end of the process, apply a moderate heat to the retort.

In this process the iron of the sulphuret is oxidized by the oxygen of the water, and the oxide of iron thus formed combines with the sulphuric acid to form sulphate of iron. The hydrogen of the water uniting with the sulphur of the sulphuret forms hydrosulphuric acid *(sulphuretted hydrogen)*.



The sulphuretted hydrogen thus produced is conveyed into a solution of ammonia, with which it combines.

Properties.—As thus prepared, the solution of hydrosulphuret of ammonia is a liquid, having a greenish yellow colour, a very fetid odour, and an acrid disagreeable taste. The mineral acids decompose it, evolve hydrosulphuric acid, and precipitate sulphur. It forms with a considerable number of metallic solutions, precipitates. With the salts of lead, bismuth, silver, and copper, the precipitates are blackish; with those of antimony, red; with those of cadmium and tin (persalts), and with the arsenites (on the addition of an acid), yellow; lastly, with the salts of zinc, white. In these cases the precipitates are either sulphurets or hydrated sulphurets of the respective metals.

By exposure to the air part of the ammonia flies off, and some sulphur is deposited. It is now a bi- or poly-sulphuret of ammonium, and yields a red precipitate with the salts of lead, a yellow one with tartar emetic, and a white one with arsenious acid.

Characteristics.—Its odour will readily distinguish it. As a sulphuret or hydrosulphuret it is known by its actions on the metallic solutions already noticed. Caustic potash causes the evolution of ammonia.

Composition.—Neutral hydrosulphate of ammonia has the following composition :—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Hydrosulphuric Acid	1	17	50·00
Ammonia	1	17	50·00
Hydrosulphate of Ammonia	1	34	100·00

	Vol.
Hydrosulphuric Acid Gas	1
Ammoniacal Gas	2

Or it may be regarded as a *Sulphuret of Ammonium* $(S + NH^4)$.

The fuming liquor (*Liquor Fumans Boyli*) obtained by distilling four parts of slacked lime, two of hydrochlorate of ammonia, and one of sulphur, contains, according to Gay-Lussac[r], hydrosulphate of ammonia, with excess of sulphur; but in what state of combination has not been determined.

Physiological Effects. α. *On Vegetables.*—The vapour of this compound is injurious to vegetation.

β. *On Animals.*—I am unacquainted with any experiments made with it on animals; but analogy leads us to believe that its action is that of a powerful poison, analogous to other alkaline sulphurets, and to hydrosulphuric acid.

γ. *On Man.*—In *small* but *repeated doses* it acts powerfully on the secreting organs, the action of which it promotes, but at the same time modifies. Its principal influence is directed to the skin (on which it acts as a sudorific), and to the pulmonary mucous membrane. In *somewhat larger doses* it occasions nausea and giddiness. In *still larger doses* it causes nausea, vomiting, diminished frequency of pulse, giddiness, extreme languor, drowsiness, and sleep. *Excessive doses* would, of course, produce death, though I am unacquainted with any case of this kind.

In the gaseous state it acts, when inhaled, as a powerfully asphyxiating agent. Instances of its deleterious operation, in conjunction with hydrosulphuric acid, have occurred in France, in workmen exposed to the vapours from the pits (cesspools) of the necessaries. The symptoms are, sudden weakness, insensibility, and death; or where the vapours are less concentrated, there are sometimes delirium and convulsions.

Uses.—In this country it has been principally employed in *diabetes mellitus*, with the view of reducing the morbid appetite and increased action of the stomach, as well as of the system in general[s]. Combined with alcohol, F. Hoffmann administered it under the name of *liquor anti-podagricus*, as a powerful sudorific in gout. It has also been used in old pulmonary catarrhs; and by Brauw and Gruithuisen in vesical catarrh[t].

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[r] *Cours de Chimie*, Leçon 20e.

[s] Rollo, on *Diabetes Mellitus*, p. 28, ed. 2nd.

[t] Vogt, *Pharmacodynamik*.

Administration.—It is given in doses of from four to six drops, in some proper vehicle (distilled water is the best). On account of its speedy decomposition, it should be dropped from the bottle at the time of using it.

Antidotes.—The antidotes for hydrosulphate of ammonia, as well as for hydrosulphuric acid, are chlorine and the chlorides of lime and soda. In cases of asphyxia by the inhalation of these substances, the treatment consists in placing the patient on his back in the open air, with his head somewhat elevated; applying cold affusion to the face and breast; producing artificial respiration of air, through which chlorine is diffused, by pressing down the ribs and forcing up the diaphragm, and then suddenly removing the pressure; using strong friction in the course of the vertebral column, chest, soles of the feet, &c., and injecting into the stomach, stimulants; as, a weak solution of chlorine (or of chloride of lime) or brandy, &c. In the event of hydrosulphuret of ammonia being by accident swallowed in poisonous doses, dilute solutions of chlorine, or of the chlorides of lime and soda, should be immediately given, and the contents of the stomach removed by the stomach-pump as soon as possible.

Class II. Metallic Substances.

Order XI. COMPOUNDS OF POTASSIUM.

1. POTAS'SÆ HY'DRAS, *L.*—HYDRATE OF POTASH.

(Potassa, *E.*—Potassa caustica, *D.*)

History.—Caustic alkaline solutions were probably known to the Greeks and Romans. We learn from Pliny[u] that soap was made in his time from tallow and wood-ashes; and we may therefore conclude that some method was known of depriving the alkaline carbonate of its carbonic acid. Geber[v] describes the method of making caustic alkali. Black, however, in the year 1756, first distinguished, chemically, the caustic alkalis from their carbonates. Potash was formerly called *kali*, or the *vegetable alkali*. It is the *Protoxide of Potassium.*

Natural History.—Potash in combination with acids is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—Potash is found, in the mineral kingdom, in combination with sulphuric, nitric, silicic, and perhaps carbonic acids. As an ingredient of rocks, it is more abundant than soda.

β. In the Organised Kingdom.—In organised beings potash is met with in combination with phosphoric, sulphuric, nitric, carbonic, and various organic acids. It occurs more abundantly in vegetables than in animals.

Preparation.—All the British Colleges give directions for the preparation of hydrate of potash.

The *London College* orders, of Solution of Potash, a gallon. Evaporate the water in a clean iron vessel over the fire, until the ebullition being finished, the Hydrate of Potash liquefies: pour this into proper moulds.

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[u] *Hist. Nat.* lib. xxviii. cap. 51.

[v] *Invention of Verity,* ch. iv.

The *Edinburgh College* directs any convenient quantity of Aqua Potassæ to be evaporated in a clean and covered iron vessel, increasing gradually the heat till an oily-looking fluid remains; a drop of which, when removed on a rod, becomes hard on cooling: then pour out the liquid upon a bright iron plate, and as soon as it solidifies break it quickly, and put it into glass bottles secured with glass stoppers.

The process of the *Dublin College* is essentially the same as that of the Edinburgh College, except that the evaporation is to be effected in vessels of silver or iron, and the liquefied potash is to be poured out on a plate of silver or iron.

PROPERTIES.—The solid hydrate of potash of the shops, known as *Potassa fusa (Kali purum; Lapis Infernalis* sive *Septicus; Cauterium Potentiale)* is usually more or less coloured (brownish, greyish, or bluish), and not completely soluble in water and alcohol, in consequence of the presence of foreign matters. Pure hydrate of potash, however, is white, and dissolves in both water and alcohol. During its solution in water, heat is evolved. Its solubility in alcohol enables us to separate it from the carbonate and bicarbonate of potash, both of which are insoluble in this liquid. It has a strong affinity for both water and carbonic acid, which it rapidly attracts from the atmosphere, and in consequence becomes liquid. At a low red heat it fuses, and at a higher temperature is volatilized. It is odourless, but has a caustic, urinous taste. It rapidly decomposes organic substances. It possesses the properties of an alkali in an eminent degree.

Characteristics.—Potash, free or combined with an acid to form a neutral salt, is recognised by the following characters:—The hydrosulphurets, ferrocyanides, and carbonates, produce no precipitate with its solutions. Tartaric (in excess), perchloric, and carbazotic acids, occasion precipitates of the bitartrate, perchlorate, and carbazotate of potash respectively. Chloride of platinum throws down a yellow precipitate. Lastly, the potash salts communicate a violet tinge to the flame of alcohol.

Free potash is distinguished from its salts by its communicating a green colour to the infusion of red cabbage or syrup of violets; by its reddening turmeric, and restoring the blue colour of litmus reddened by an acid; by its not whitening lime water, or effervescing on the addition of an acid; by its soapy feel; by its solubility in alcohol; and by its dissolving alumina.

IMPURITIES.—Potassa fusa of the shops contains various impurities, such as sesquioxide of iron, carbonate of potash, and silica. These, however, do not materially affect its medicinal value.

> "Boiling water commonly leaves oxide of iron undissolved, which should not exceed 1·25 per cent.: the solution neutralized with nitric acid gives a faint precipitate with a solution of nitrate of baryta, and more with solution of nitrate of silver,—owing to the presence of impurities." *Ph. Ed.*

The nitrate of baryta detects sulphates, while nitrate of silver is a test for chlorides.

COMPOSITION.—Pure *anhydrous potash* has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potassium	1	40	83·34	83·05
Oxygen	1	8	16·66	16·95
Potash	1	48	100·00	100·00

The *hydrate of potash* is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Potash	1	48	84·2	84
Water	1	9	15·8	16
Hydrate of Potash	1	57	100·0	100

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.* — Caustic potash promptly destroys the parts of living plants with which it is placed in contact, and even in the dilute state kills haricots (*Phaseolus vulgaris*) in a few hours[w].

β. On Animals generally.—It acts on animals generally as an energetic caustic poison. It is, says Orfila[x], of all poisons, that which most frequently perforates the stomach. He found, that injected into the jugular vein of a dog, it coagulated the blood, and caused speedy death. It is, however, remarkable, that when mixed with the blood out of the body, it not only does not coagulate it, but actually prevents its spontaneous coagulation. Magendie has observed, that by the exhibition of alkalis to dogs, the urine acquires alkaline properties.

γ. On Man.—The general operation of alkalis has been already noticed (see pp. 194 and 213). The local action of caustic potash, especially when in the solid form, is exceedingly energetic. It neutralizes any free acid in the part to which it is applied, and decomposes whatever ammoniacal salts may be present, causing the evolution of ammoniacal gas. It combines with fibrin and albumen, forming soluble compounds (*fibrate* and *albuminate of potash*). Hence, rubbed between the fingers, it corrodes and dissolves the epidermis, and thereby gives rise to a soapy feel. Gelatine is also readily dissolved by it, and any phosphate of lime which may be present is deposited. These phenomena are to a certain extent comparable to those of saponification. As, then, potash and the other alkalis form soluble compounds with substances which enter largely into the composition of the organized tissues, we can readily explain an observation of Orfila, that alkalis are, of all corrosive poisons, those which most frequently perforate the stomach; for the intestinal mucus readily dissolves in alkalis, whereas it is coagulated by acids; so that the former are much more quickly brought in contact with the living tissues. These resist, for a certain time, the chemical influence of the caustics, but the affinities being powerful, the vital properties soon cease to offer opposition—the part dies, and the tissues are speedily dissolved. Hence, if a large quantity of potash be swallowed, the most violent symptoms are observed, though they are of the same general kind as when the mineral acids have been taken (see p. 105).

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[w] Marcet, in De Candolle, *Phys. Végét.*
[x] *Toxicol. Génér.*

When liquor potassæ is taken in small doses, and properly diluted, it saturates the free acids contained in the stomach, and which the recent investigations of physiologists have shown to be essential to the digestive functions. Hence the continued use of this or of any other alkali must be always injurious, since it disorders the assimilative process by altering the chemical properties of the healthy ventricular secretion.

If the quantity of potash swallowed be more than sufficient to neutralize the free hydrochloric acid, but insufficient to exert any important chemical action on the living tissues, it acts as a slight irritant, augments the secretions of the alimentary canal, becomes absorbed, and alters the qualities of the secreted fluids, more particularly those of the urine (see pp. 102 and 108). Moreover, the modification thus produced in the quality of the renal secretion is accompanied by an increase in the quantity, so that the alkalis rank among our most powerful diuretics—an effect which may be in part owing to the local stimulus which they communicate to the secreting vessels in their passage through them.

By continued use, the alkalis give rise to increased activity of the different secreting organs, and of the absorbing vessels and glands; effects which are analogous to those caused by mercury. In other words, they act as *liquefacients* and *resolvents* (see p. 194). After some time the digestive function becomes disordered, the appetite fails, the blood becomes thinner and darker coloured, and loses its power of spontaneous coagulation when drawn from the body; the whole system, and more particularly the digestive organs, become enfeebled; and a state precisely similar to that of scurvy is brought on. It is said if the alkalis be temporarily suspended the blood speedily re-acquires its coagulability, but loses it again when we resume their employment. These phenomena deserve especial notice, as being precisely analogous to those of scurvy—a disease which has been usually supposed to be brought on by the use of salt and salted provisions, and to be prevented or cured by vegetable acids (especially the citric) and fresh provisions. It appears, therefore, in the highest degree probable, that scurvy, and the effects caused by the long-continued employment of the alkalis, are analogous conditions of system (see the effects of ammonia, p. 312).

USES.—Caustic potash is employed for various purposes in medicine, the principal of which are the following:—

a. As an escharotic.—Potassa fusa is sometimes used as a caustic, though its employment is not free from objection; for its great deliquescence occasions some difficulty in localizing its action. It may be employed for the production of an issue, but we must proceed thus:—Apply to the part one or two layers of adhesive plaster, in the middle of which is an aperture of the exact size of the intended issue. Then moisten the *potassa fusa*, or the *potassa cum calce*, and rub on the part until discolouration is observed. Wash, and apply a linseed-meal poultice; and when the eschar is detached, insert the pea.

Issues, however, are speedily and more conveniently made by the lancet than by caustic. In bites by poisonous animals—as venomous serpents, mad dogs, &c., this escharotic may be used with advantage. Mr. Whateley[y] recommends the *potassa fusa* as the agent for arming caustic bougies to be applied in strictures of the urethra; but the practice appears so dangerous (particularly on account of the deliquescence and violent action of the caustic), that I believe it is now rarely, if ever, resorted to. There are many other cases in which this substance is employed as a caustic: for example, to destroy warts and fungoid growths of various kinds, and to open abscesses, more especially those in the groin; but for the latter purpose the lancet is to be preferred.

β. As an *antacid* we resort to the *liquor potassæ* in various affections of the digestive organs, which are attended with an inordinate secretion of acid, known by the acid eructations, cardialgia, and other dyspeptic symptoms. It must, however, be evident, that the neutralization of the acid is merely palliative. But the continued employment of alkalis frequently diminishes, temporarily, the tendency to acid secretion. Commonly it is found that the cases calling for the employment of alkalis are those benefitted by tonics, and hence I believe the alkali is, in most cases, best given in some mild or tonic infusion; such, for example, as the infusion of calumba, or of gentian, or of quassia; the disulphate of quina oftentimes disagreeing with the stomach in these cases: besides which, it would be decomposed by the alkali. The beneficial effects of alkalis are said to be particularly observed in those forms of dyspepsia which result from the inordinate use of spirituous liquors.

Of course the liquor potassæ would equally neutralize acid which may have been accidentally or purposely swallowed; but it is rarely given for this purpose, on account of its irritant qualities, and because many other agents (as chalk, whiting, magnesia, and soap) are equally efficacious as antacids, while they are free from the objections which exist in these cases to the use of the caustic alkalis.

γ. *To modify the quality of the urine*, liquor potassæ is a most valuable agent. I have already stated (see p. 102) that, under the employment of alkalis, not only may the natural acidity of the urine be destroyed, but even an alkaline property be communicated to it: so that, whenever the secretion of lithic acid, or of the lithates, is inordinate, the alkalis present themselves to our notice as chemical agents for counteracting this condition. It has been supposed by some that the efficacy of the caustic alkalis in preventing the deposition of lithic acid gravel, consists in their holding it in solution—an explanation apparently inconsistent with the fact that the carbonated alkalis and magnesia are equally efficacious, though they are incapable of dissolving it. We are, therefore, led to the conclusion, that the alkalis, by their chemical influence, actually prevent the formation of this acid, or neutralize the free acid in the urine, which is the immediate cause of the precipitation of the lithic acid; whether by an action on the digestive organs or otherwise we know not. In resorting to these agents in urinary deposits, we should be careful to avoid employing them when there is any tendency to the deposition of the phosphates. The phosphate of lime, which naturally exists in the urine, is precipitated by the addition of a caustic alkali. It is generally admitted that the use of alkalis may actually cause the appearance of *white sand* (phosphates) in the urine; and in patients predisposed to its formation, its quantity may be increased by alkalis. These facts, then, have an important bearing on practice. "I have known," says Mr. Brande[z], "soda-water exhibited in a case of stone in the bladder, *produce* abundance of white sand, which the ignorance of the patient and his medical attendant led them to refer to the solvent power of the medicine upon the stone, which they thought was gradually giving way and being voided; whereas great mischief was doing, by giving the urine more than its usual tendency to deposit the phosphates, and, consequently, to augment the size of the calculus." In the treatment of the lithic acid diathesis, it is to be remembered that the use of alkalis is, to a certain extent, a palliative mode of treatment, and that, to be successful, it should be conjoined with other means of cure.

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[y] *An Improved Method of Treating Strictures of the Urethra.* Lond. 1804.

δ. *As a liquefacient and resolvent* (see p. 194).—The alkalis have been lately celebrated for producing beneficial effects in those *inflammations* which have a disposition to terminate in exudation and adhesion; that is to say, those that frequently give rise to the formation of false membranes or of adhesions; such, for example, as croup, pleurisy, and peritonitis. If experience should subsequently confirm the assertions already made respecting their efficacy, we shall have another analogy between the operation of alkalis and of mercury. Theoretically, it has been argued, the alkalis are likely to be beneficial in these diseases on two accounts; first, they have a tendency to diminish the supposed plasticity of the blood, which some have assumed (though without proof) to be connected with the exudation; and, secondly, we find these albuminous deposits readily dissolve, out of the body, in alkaline liquids: but arguments of this kind are to be received with great caution. In conclusion, I may add that Eggert recommends the alkalis as specifics against croup, though Sundelin[a] found them ineffective. Hellwag employed them to cause the removal of the deposited lymph; Memminger gave them with benefit in hooping-cough; Mascagni in pleurisy and peripneumony[b]. In the latter complaints the alkalis render the expectorated matter less viscid, and at the same time act on the kidneys and skin.

ε. In *induration* and *enlargement of the lymphatic* and *secreting glands* the alkalis have also been recommended: for example, in bronchocele, mammary tumors, affections of the testicle, diseases of the mesenteric glands, induration of the liver and salivary glands, &c. I have seen the liquor potassæ remarkably beneficial in excessive enlargement of the lenticular or glandular papillæ at the base of the tongue.

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[z] *Quart. Journ. of Science*, vol. vi. p. 198.
[a] *Heilmittell.* 1^{er} Bd. S. 182.
[b] Vogt, *Lehrbuch d. Pharmakodyn.* 2^{er} Bd. p. 529.

ζ. In *syphilis* and *scrofula* also the alkalis have been employed with advantage. Some of the most obstinate and troublesome forms of the venereal disease frequently occur in scrofulous subjects, in whom mercury is not only useless, but absolutely prejudicial. In several cases of this kind I have seen the liquor potassæ, taken in the compound decoction of sarsaparilla, of great benefit. In scrofula the long-continued use of the caustic alkalis (as potash and ammonia) has been attended with remarkably beneficial effects. Caustic potash was most extensively employed by Mr. Brandish[c], during many years, in the treatment of scrofula and other chronic diseases, and, according to his report, with singular success. It is, however, more successful in young than in old persons,—and in those of fair and light complexion than in the dark and the swarthy. That, in a number of instances, scrofulous patients are greatly benefited by its use, cannot be denied; but I doubt whether this, or any other medicine, has the power of eradicating the disease from the system.

η. The alkalis have been employed as *diuretics in dropsy*, especially when this disease arises from glandular enlargements, or other causes likely to be relieved by these remedies.

ϑ. In *irritable conditions of the urinary organs* a combination of liquor potassæ and tincture of opium will be frequently found most beneficial, notwithstanding that alkalis are classed among the incompatibles of opium.

ι. There are several other diseases in which the employment of alkalis has been recommended; such as *skin diseases*, which are scaly (as lepra and psoriasis); *chronic rheumatism;* in *uterine complaints*, as an emmenagogue; and in some chronic *diseases of the lungs.* Sometimes a very dilute solution of potash has been used as a *stimulating wash* to ulcers.

Antidotes.—In poisoning by the alkalis, the antidotes are either acids or oil, both of which form salts with the alkalis, and diminish their causticity. Chereau prefers oil. Vinegar, lemon or orange juice, even the very diluted mineral acids, should be resorted to, if oil be not at hand.

1. LIQUOR POTASSÆ, L.; *Potassæ Aqua*, E.; *Potassæ Causticæ Aqua*, D.; *Solution of Potash; Water of Caustic Potash; Lixivium Saponarium.*—This is a solution of caustic potash.

The *London College* orders of Carbonate of Potash, ℥xv.; Lime, ℥viij.; Distilled Water, boiling, *Cong.* j. Dissolve the Carbonate of Potash in half a gallon of the water. Sprinkle a little of the water upon the lime in an earthen vessel, and the lime being slacked, add the rest of the water. The liquors being immediately mixed together in a close vessel, shake them frequently until they are cold. Then set by [the mixture], that the Carbonate of Lime may subside. Lastly, keep the supernatant liquor, when poured off, in a well-stoppered green glass bottle.

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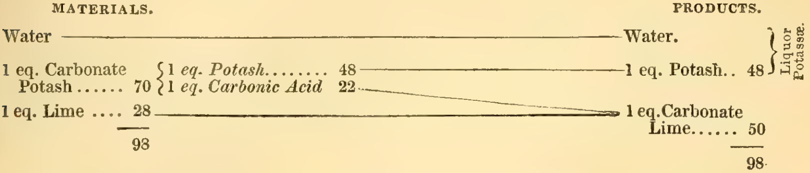
[c] *Observations on the Use of Caustic Alkali in Scrofula and other Chronic Diseases.* Lond. 1811

The *Edinburgh College* directs of Carbonate of Potash, dry, ℥iv.; Lime recently burnt, ℥ij.; Water, f℥xlv. Let the lime be slaked and converted into milk of lime, with seven ounces of the water. Dissolve the carbonate in the remaining thirty-eight fluidounces of water; boil this solution, and add to it the milk of lime in successive portions, about an eighth at a time,—boiling briskly for a few minutes after each addition. Pour the whole into a deep narow glass vessel for twenty-four hours; and then withdraw with a syphon the clear liquid, which should amount to at least thirty-five fluidounces, and ought to have a density of 1·072.

The *Dublin College* employs of Carbonate of Potash, from Potashes of Commerce; Fresh burnt Lime, of each, two parts; Water, fifteen parts.—The process is not essentially different from that of the London College. The specific gravity of this product is 1·080.

In all these processes the lime abstracts carbonic acid from the carbonate of potash, forming carbonate of lime, and the potash thus set free dissolves in the water.



The liquid should be decanted or drawn off by a syphon. Filters are objectionable, as the potash decomposes and partially dissolves them. Cotton and linen are less acted on by it than paper or woollen cloth, which are readily decomposed by it. The air must be excluded as much as possible during the process of filtration, as the liquor abstracts carbonic acid from the air.

Liquor potassæ is a limpid, colourless, transparent, inodorous liquid, having an acrid taste. Prepared according to the London Pharmacopœia, its sp. gr. is 1·063; according to the Edinburgh Pharmacopœia, 1·072; while, according to the Dublin College, it is 1·080. It has a soapy feel when rubbed between the fingers, and reddens yellow turmeric paper. It strongly attracts carbonic acid from the atmosphere, and, therefore, should be kept in closed vessels. It corrodes flint glass, and on that account should be preserved in green glass bottles.

It usually contains a small quantity of carbonate of potash, which may be detected by lime water, which renders the liquid turbid, or by a diluted mineral (sulphuric or nitric) acid, which causes effervescence. When pure liquor potassæ has been saturated with diluted nitric acid, it gives no precipitate on the addition of carbonate of soda, chloride of barium, or nitrate of silver: if the first cause a precipitate, it would indicate some earthy or metallic impregnation; if there be a precipitate, insoluble in nitric acid with the second, we infer the presence of a sulphate; and, lastly, if the third occasions a precipitate, soluble in ammonia, but insoluble in nitric acid, a chloride is present.

The effects and uses of this liquid have been above described. The dose of it is ten drops, gradually increased to the extent of a fluidrachm, or even more, carefully watching its effects. It may be conveniently exhibited in the infusion of orange-peel. Table beer completely disguises the nauseous flavour of the alkali, but the vegetable acid of the beer partly neutralizes the alkali, especially when the beer is sour. Veal broth is another liquid for its administration. *Dr. Chittick's nostrum* for the stone is said to be a solution of alkali in veal broth.

2. POTASSA CUM CALCE, L. E.; *Potassa Caustica cum Calce,* D. —*Potash with Lime.* The following are the directions for preparing this compound:—

According to the *London College,* Hydrate of Potash, and Lime, of each an ounce, are to be rubbed together, and kept in a well-stoppered vessel.

The *Edinburgh College* directs, that any convenient quantity of Aqua Potassæ be evaporated in a clean covered iron vessel to one-third of its volume; add slacked lime till the fluid has the consistence of firm pulp: preserve the product in carefully covered vessels.

The process of the *Dublin College* is similar to that of the Edinburgh College.

By admixture with lime, hydrate of potash is rendered less deliquescent. Potassa cum Calce is employed as an escharotic in the same cases as Potassa fusa. When used it is made into a paste with rectified spirit, and applied to the part to be cauterized.

Brandish's Alkaline Solution.—Take of best American Pearlashes, lbvj.; Quicklime, fresh prepared; Woodashes (from the Ash), of each lbij.; Boiling Water, *Cong.* vj. Add first the lime, then the pearlashes, and afterwards the woodashes to the boiling water; then mix. In twenty-four hours the clear liquor may be drawn off.—In this process the lime decomposes the carbonate of potash contained in pearlashes and woodashes, and combines with the carbonic acid, setting free the potash. The liquid, therefore, is a solution of caustic potash contaminated with some soluble alkaline salts (sulphate of potash and chloride of potassium). The solution is stronger than the officinal *liquor potassæ,* but is liable to vary in strength, in consequence of the varying quality of the ashes used.—Dose, according to Mr. Brandish, for an adult, is three (or even four) teaspoonfuls; for children, of from four to six years of age, one small teaspoonful; from six to eight years, a teaspoonful and a half; from eight to fifteen, two teaspoonfuls; and from fifteen to eighteen years, two teaspoonfuls and a half. The dose is to be taken twice daily, between breakfast and dinner, and at bedtime, in fresh small beer or ale. A drop or two of oil of juniper covers the saponaceous taste, and gives a grateful smell. A generous regimen, and a careful avoidance of acids, were employed by Mr. Brandish, in conjunction with the alkaline liquor. In scrofulous tumours mercurial ointment was rubbed in.

2. POTAS'SII IO'DIDUM, *L. E.*—IODIDE OF POTASSIUM.

(Potassæ Hydriodas, *D.*)

History.—This salt, called also *ioduret of potassium,* and more commonly *hydriodate of potash,* was first employed in medicine by Dr. Coindet.

Natural History.—Iodine and potassium are contained in sea-water as well as in sea-weeds, but whether the iodine is in combination with potassium or with some other metal (sodium or magnesium) it is impossible to say with certainty (see p. 232).

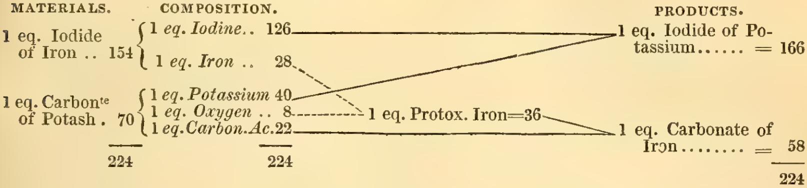
Preparation.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Iodine ℥vj.; Carbonate of Potash, ℥iv.; Iron Filings, ℥ij.; Distilled Water, Ovj. Mix the Iodine with four pints of the Water, and add the Iron, stirring them frequently with a spatula for half an hour. Apply a gentle heat, and, when a greenish colour appears, add four ounces of carbonate of potash, first dissolved in two pints of water, and strain. Wash the residue with two pints [of boiling distilled water, and again strain. Let the mixed liquor be evaporated, that crystals may be formed.

The *Edinburgh College* employs of Iodine (dry) ℥v.; Fine Iron-Wire, ℥iij.; Water, Oiv.; Carbonate of Potash (dry), ℥ij. and ʒvj. The process is much the same as that of the London College, except that the solution of iodide of potassium is to be concentrated "till a dry salt be obtained, which is to be purified from a little red oxide of iron and other impurities, by dissolving it in less than its own weight of boiling water, or, still better, by boiling it in twice its weight of rectified spirit, filtering the solution, and setting it aside to crystallize. More crystals will be obtained by concentrating and cooling the residual liquor."

The following is the *theory* of the above processes:—One equivalent or 126 parts of iodine combine with one equivalent or 28 parts of iron. The resulting iodide of iron is decomposed by one equivalent or 70 parts of carbonate of potash, by which one equivalent or 166 parts of iodide of potassium and one equivalent or 58 parts of protocarbonate of iron are procured.

The following diagram illustrates the reaction between iodide of iron and carbonate of potash.



Prepared by this process, iodide of potassium is apt to be contaminated with carbonate of potash.

The process of the *Dublin College* is as follows:—Take of Iodine, one part; Sulphuret of Iron, reduced to coarse powder, five parts; Sulphuric Acid, seven parts; Distilled Water, forty-eight parts; Water of Carbonate of Potash, a sufficient quantity; Rectified Spirit, six parts. Mix the iodine, by trituration, with sixteen parts of the water, and put the mixture into a glass vessel. Pour the acid, previously diluted with thirty-two parts of water, upon the sulphuret in a matrass, and from a tube, adapted to the neck of the matrass, and reaching to the bottom of the vessel containing the iodine and water, let the gas pass through the mixture until the iodine disappears. Having filtered the liquor, evaporate it without delay, by a superior heat, to one-eighth part, and then filter it again. Then add gradually as much water of carbonate of potash as will be sufficient to saturate the acid, which is known by the cessation of the effervescence. Then expose the mixture to heat until the residual salt is dry and of a white colour; on this pour the spirit, and dissolve it with heat. Lastly, evaporate to dryness the liquor poured off from the residual salt, and preserve the residuum in a well-stoppered vessel.

By the mutual action of sulphuret of iron, water, and sulphuric acid, we obtain, in this process, sulphuretted hydrogen and sulphate of iron (see p. 478). The sulphuretted hydrogen being conveyed into water with which iodine is mixed, a solution of hydriodic acid is obtained, and sulphur is deposited. When the hydriodic acid and carbonate of potash are mixed, mutual re-action occurs, and the products are iodide of potassium, water, and free carbonic acid.

Another mode of preparing this salt was proposed by the late Dr. Turner. It consists in adding to a hot solution of caustic potash as much iodine as the liquid will dissolve, by which means a reddish-brown fluid is obtained. Then pass hydrosulphuric acid through the liquid until it becomes colourless. Apply a gentle heat, to expel any excess of the acid; filter, to get rid of the free sulphur, and exactly neutralize the free acid present, with potash; then crystallize. When the potash comes in contact with iodine two salts are formed, iodide of potassium and iodate of potash: the latter is decomposed by the hydrosulphuric acid, the hydrogen of which forms water, by combining with the oxygen of the iodate; sulphur is precipitated, and iodide of potassium remains in solution.

Instead of decomposing, by sulphuretted hydrogen, the mixture of iodate of potash and iodide of potassium, it may be subjected to a red heat, in a crucible of platinum or iron. The iodate gives out six equivalents of oxygen, and is converted into iodide of potassium. A little iodate is, however, apt to escape decomposition.

Mr. Scanlan informs me, that if powdered charcoal be intermixed with the two salts before they are subjected to heat, the deoxidation of the iodate is easily effected.

PROPERTIES.—This salt occurs in white, somewhat shining, transparent, or semi-opaque cubes, or octohedrons, belonging to the regular system. Its taste is acrid saline, somewhat similar to common salt: it is without odour. It fuses at a red heat, and at a high temperature volatilizes unchanged. It decrepitates when heated. Both water and alcohol readily dissolve it: it requires only two-thirds of its weight of water to dissolve it at 60° F. Its aqueous solution dissolves iodine, forming a liquid called *ioduretted iodide of potassium.*

Characteristics.—A solution of this salt is known to contain an *iodide* by the following tests:—

α. A solution of bichloride of mercury occasions a vermilion-red precipitate *(biniodide of mercury)*, soluble in excess of iodide of potassium.

β. A solution of acetate of lead produces a yellow precipitate (*iodide of lead*).

γ. A solution of nitrate of silver causes a pale yellow precipitate *(iodide of silver)*.

δ. Protonitrate of mercury or calomel occasions a greyish or a greenish yellow precipitate *(protiodide of mercury)*.

ε. On the addition of a cold solution of starch and a few drops of nitric acid (or solution of chlorine, or, still better, according to Devergie, a mixture of chlorine and nitric acid) a blue compound (*iodide of starch*) is formed, which is decolorized at a boiling temperature, or by caustic alkali.

ϑ. Bichloride of platinum renders the solution brownish red (*biniodide of platinum*).

That the base of the salt is potassium (or potash) is proved by the following characters:—

α. Perchloric acid occasions a white precipitate (*perchlorate of potash*), while the supernatant liquor becomes yellowish brown, from a little free iodine.

β. Excess of a strong solution of tartaric acid produces a white crystalline precipitate (*bitartrate of potash*).

γ. Carbazotic acid forms yellow needle-like crystals (*carbazotate of potash*).

δ. If a clean pack-thread be soaked in a solution of the iodide, and the wetted end be immersed in melted tallow and applied to the exterior or blue cone of the flame of a candle, this cone assumes a pale or whitish violet tint.

Composition.—This salt consists, as its name indicates, of iodine and potassium.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*
Iodine	1	126	76	76·2
Potassium	1	40	24	23·8
Iodide Potassium	1	166	100	100·0

The crystals contain no water of crystallization.

Adulteration.—Iodide of potassium is often largely adulterated with *carbonate of potash*. In 1829 I analyzed a sample, which contained 77 per cent. of the latter salt[d]. In one specimen Dr. Christison procured 74·5 per cent. of carbonate of potash, 16 of water, and only 9·5 of iodide of potassium[e]. The impure salt may be distinguished by its wanting any regular crystalline form; by adding a few particles of it to lime-water, a milky fluid (*carbonate of lime*) is obtained, whereas the liquid remains transparent if the iodide be pure; by its destroying the colour of tincture of iodine, whereas the pure salt does not affect it; and lastly, by alcohol, which dissolves iodide of potassium, but not carbonate of potash.

Traces of the chlorides and sulphates are not unfrequent in commercial iodide of potassium. To detect the *chlorides*, add nitrate of silver, which precipitates the carbonates, chlorides, and iodides, and digest the precipitate in ammonia, which redissolves the chloride, but not the iodide of silver. On the addition of nitric acid to the ammoniacal solution, the chloride is thrown down, while the carbonate is converted into nitrate of silver. The *sulphates* may be detected by chloride of barium, which will occasion a white precipitate (*sulphate of baryta*) insoluble in nitric acid.

In the first edition of this work I mentioned that I had met with a variety of iodide of potassium, which, by keeping, underwent decomposition, evolved an odour of iodine, and became yellow. As it yielded me, on analysis, iodine and potash only, I was unable to account for the changes just referred to. Mr. Scanlan[f] has since explained them; and shewn that this variety of iodide of potassium is contaminated with *iodate of potash*, the presence of which has been already accounted for (see page 490). It may be readily detected, by adding to a solution of the suspected iodide a solution of tartaric acid. If the iodide be pure, the resulting liquor is at first colourless, but becomes quickly yellow by the action of atmospheric oxygen on the hydriodic acid which is thus generated. If, however, iodate of potash be also present, a quantity of free iodine is instantly developed. This arises from the mutual re-action of the disengaged hydriodic and iodic acids by which water and free iodine are generated. Whether iodate be present or absent, the addition of tartaric acid causes the precipitation of crystals of bitartrate of potash.

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[d] *Med. and Phys Journ.* Sept. 1829.

[e] *Treatise on Poisons*, 3d edit. p. 182.

[f] *Lancet*, Aug. 29, 1840, p. 816.

Iodide of potassium is readily contaminated with metallic matter derived from the vessels in which it is crystallized. I have samples of it, in octohedral crystals, which contain traces of lead and tin, derived, I presume, from the metallic vessels in which they have been prepared.

The following are the characters of pure iodide of potassium according to the *London College*:—

> Totally soluble in water and in alcohol. It alters the colour of turmeric either not at all or very slightly. It does not alter the colour of litmus. Subjected to heat it loses no weight. Sulphuric acid and starch added together it becomes blue. Ten grains of this salt are sufficient to decompose 10·24 grains of nitrate of silver: what is precipitated is partly dissolved by nitric acid, and partly altered in appearance; which is not the case when ammonia is added.

The non-action on turmeric proves the absence of alkali (or its carbonate) and acid. If it decompose more than the above quantity of nitrate of silver, the presence of chloride of potassium may be suspected.

The *Edinburgh College* gives the following characters of the pure iodide:—

> Its solution is not affected, or is merely rendered hazy, by solution of nitrate of baryta. A solution of five grains, in a fluidounce of distilled water, precipitated by an excess of solution of nitrate of silver, and then agitated in a bottle with a little aqua ammoniæ, yields quickly, by subsidence, a clear supernatant liquor, which is not altered by an excess of nitric acid, or is rendered merely hazy.

The nitrate of baryta will form a white precipitate with either an alkaline carbonate or sulphate. The nitrate of silver is used to detect any chloride.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—The effects of this salt on vegetables have not been ascertained.

β. On Animals generally.—The experiments of Devergie[g] on dogs, as well as those of Dr. Cogswell[h] on rabbits, have shewn that, to these animals, iodide of potassium is a powerful poison. It operates as a local irritant, and thereby inflames the tissues with which it is placed in contact. Four grains injected into the jugular vein of a dog caused convulsions and death within a minute. Two drachms introduced into the stomach gave rise to vomiting and great depression; the latter increased until death, which occurred on the third day: after death, ecchymosis, ulceration, and redness of the stomach, were observed[i]. Dr. Cogswell injected three drachms of the iodide beneath the skin of the back of a dog; the animal died on the third day. On chemical examination, iodine was detected in the blood from the heart, in the brain and spinal cord, the liver, spleen, stomach, muscles, tongue, and the bones freed from their appendages; likewise in the contents of the bladder[j].

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[g] *Médecine Légale*, t. ii. p. 536.
[h] *Experimental Essay on Iodine.* Edinb. 1837.
[i] Devergie, *op. cit.* p. 506.

γ. *On Man.*—Both the physiological effects and therapeutical uses of iodide of potassium shew that its operation is analogous to that of iodine.

The *local action* of iodide of potassium is that of an irritant. When taken internally, in large does, it not unfrequently occasions nausea, vomiting, pain and heat of stomach, and purging. Applied to the skin in the form of ointment, it sometimes produces slight redness. It is much less energetic in its action than free iodine; and, therefore, may be given in larger doses, and continued for a longer period, without evincing the same tendency to produce disorder of the stomach and intestinal canal. Lugol[k] found that baths at 100° F., containing three ounces of iodide of potassium, produced temporary itching only; whereas baths at the same temperature, containing ten scruples of iodine, caused prickling, then itchiness, smarting, rubefaction (which was not commensurate with the itchiness), punctuated, separated, or confluent, and subsequently desquamation of the epidermis. The chemical action of iodide of potassium on the tissues is slight, as, indeed, might be expected, seeing that no obvious changes are produced when a solution of this salt is mixed with albumen, fibrin, or gelatine, the three most abundant organic constituents of the animal body.

Iodide of potassium *becomes absorbed* and is carried out of the system by the different secretions, in which, as well as in the blood, it may be easily detected[l]. Moreover, it deserves especial notice, that it has been found in the urine several days after it has been swallowed[m]. To detect it in the urine, add first starch to the cold secretion, then a few drops of nitric acid (or solution of chlorine), and the blue iodide of starch will be formed if the iodide be present.

The *remote* or *constitutional effects* of iodide of potassium are very analogous to those of iodine. Diuresis is a common consequence of its use. Relaxation of bowels is not unfrequent. Occasionally ptyalism has been observed[n]. Dr. Wallace mentions that irritation of throat is produced by this salt. Atrophy of the mammæ is a very rare effect of it, but a case is mentioned by Mr. Nesse Hill[o]. Wasting of the testicle also is said to have resulted from its use[p]. Headache, watchfulness, and other symptoms indicative of the action of this salt on the nervous system, have been noticed by Dr. Clendinning and Dr. Wallace. Increased secretion from, and pain of, the mucous membrane lining the nasal passages, have been observed. I have repeatedly remarked, that the pocket-handkerchiefs used by patients, who are taking this salt, acquire a distinct odour of iodine.

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[j] Cogswell, *op. cit.* p. 91.

[k] *Essays on the Effects of Iodine in Scrofulous Diseases*, translated by Dr. O'Shaughnessy, p. 65. Lond. 1831.

[l] Buchanan, *Lond. Med. Gaz.* vol. xviii. p. 519; Wallace, *Lancet*, for 1835-36, vol. ii. p. 6: the latter authority failed to detect it in the blood.

[m] Christison, *Treatise on Poisons*, 3rd ed. p. 185.

[n] Dr. Clendinning, *Lond. Med. Gaz.* vol. xv. p. 869; and Dr. Wallace, *Lancet*, for 1835 and 1836, vol. ii. p. 8.

[o] *Edinb. Med. and Surg. Journ.* vol. xxv. 1826, p. 282.

[p] *Lancet*, Oct. 16, 1841.

Great discrepancy exists in the statements of authors as to the effects of given doses of iodide of potassium. "The average dose of this medicine," says Dr. Williams[q], "is eight grains; carried beyond that quantity it purges; and even limited to that quantity, it requires some management to obviate nausea." In two cases mentioned by Dr. Wallace[r] a drachm of this salt taken in divided doses caused vomiting, colicky pains, slight diarrhœa, frequency of pulse, and exhaustion. These statements, then, show that this salt possesses very active properties, and coincide with the experience of many practitioners, and with the results obtained from the experiments on animals. But we have, in opposition to the above, the evidence of Dr. Elliotson[s] and of Dr. Buchanan[t]. The first tells us that six drachms may be given daily (in doses of two drachms) for many weeks without inconvenience; and the second states half an ounce may be given at a dose without producing pain of the stomach or bowels, purging, or any hurtful effect. Furthermore, both physicians vouch for the purity of the salt employed. It is difficult to explain such discrepancies. But I cannot help thinking that peculiarities of constitution and morbid conditions of system (especially affections of the stomach) are principally concerned in modifying (either increasing or diminishing) the tolerance to this salt. I do not think that the different effects observed can be wholly ascribed to alterations in the quality or adulterations of the medicine employed, though I have published a case[u], showing that the adulterated is much less active than the pure salt.

Uses.—Having so fully detailed (p. 240 *et seq.*) the uses of iodine, it is unnecessary to notice at any length those of iodide of potassium, since they are for the most part identical. Thus it has been employed in bronchocele, scrofula, in chronic diseases accompanied with induration and enlargement of various organs, in leucorrhœa, secondary syphilis, periostitis, articular rheumatism, dropsies, &c. As a remedy for the hard periosteal node brought on by syphilis, it was first employed by Dr. Williams[v], who obtained with it uniform success. At the end of from five to ten days its mitigating effects are felt; the pains are relieved, the node begins to subside, and in the majority of cases disappears altogether. In these cases Dr. Clendinning[w] has also borne testimony to its efficacy. In the tubercular forms of venereal eruptions, Dr. Williams found it beneficial. In Dr. Wallace's lectures[x] are some valuable observations on the use of iodide of potassium in venereal diseases. In chronic rheumatism accompanied with alteration in the condition of the textures of the joint, it is, in some cases, remarkably successful[y]. As an ingredient for baths, Lugol[z] found the iodide would not answer alone, but that it was useful as a solvent means for iodine.

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[q] *Lond. Med. Gaz.* vol. xiv. p. 42.—See also *Lancet*, Oct. 16, 1841.
[r] *Lancet*, for 1835-6, vol. ii. p. 9.
[s] *Ibid.* vol. i. 1831-2, p. 728.
[t] *Lond. Med. Gaz.* vol. xviii. p. 519.
[u] *Ibid.* vol. xvii. p. 839.
[v] *Ibid.* vol. xiv. p. 42.
[w] *Ibid.* vol. xv. p. 833.
[x] *Lancet*, for 1835-36, vol. ii. and for 1836 and 1837, vols. i. and ii.
[y] Dr. Clendinning, *Lond. Med. Gaz.* vol. xv. p. 866; and Dr. Macleod, *Lond. Med. Gaz.* vol. xxi. p. 361.

ADMINISTRATION.—Iodide of potassium may be employed alone or in conjunction with iodine, forming what is called ioduretted iodide of potassium. *Internally* it has been given alone in doses varying from three grains to half an ounce (see p. 494). To be beneficial, some think it should be given in small, others in large doses. Not having had any experience of the effects of the enormous doses before referred to, I can offer no opinion thereon. It may be administered dissolved in simple or medicated water, or in some bitter infusion. The more usual mode of exhibiting it is in combination with iodine.

ANTIDOTES. — No chemical antidote is known. In a case of poisoning, therefore, the first object will be to evacuate the contents of the stomach, exhibit demulcent and emollient drinks, combat the inflammation by the usual antiphlogistic measures, and appease the pain by opiates.

1. **UNGUENTUM POTASSII IODIDI**; *Unguentum Potassæ Hydriodatis*, D. *Ointment of Iodide of Potassium.* (Iodide of Potassium, ℈j.; Prepared Hog's-Lard, ℥j. Mix.)—By keeping, this ointment is apt to acquire a yellowish colour, obviously from a little iodine being set free. In some cases this may depend on the iodide being contaminated with a little iodate of potash. It usually, however, arises from the action of the fatty acid (contained in the rancid fat) on the potassium of the iodide. When pure and fresh made, this ointment does not stain the skin like the compound ointment of iodine. It is, however, seldom employed. If used, its strength should be twice or thrice that of the Dublin preparation.

2. **UNGUENTUM IODINII COMPOSITUM**, L. *Unguentum Iodinei*, E. *Compound Ointment of Iodine; Ointment of Ioduretted Iodide of Potassium.* (Iodine, ʒss.; Iodide of Potassium, ʒj.; Rectified Spirit, fʒj.; Lard, ℥ij. First rub the iodine and iodide of potassium with the spirit, then mix with the lard, *L.* The *Edinburgh College* omits the spirit, but uses the same proportions of the other ingredients).—This ointment is employed in bronchocele, enlargement of the lymphatic glands, &c.

3. **TINCTURA IODINII COMPOSITA**, L. *Compound Tincture of Iodine.* (Iodine, ℥j.; Iodide of Potassium, ℥ij.; Rectified Spirit, Oij. Macerate until they are dissolved, and strain).—This solution may be mixed with water, without any deposition of iodine. The dose at the commencement is ♏x. which may be gradually increased to fʒj. or more. When wine is admissible, sherry is a good vehicle for its exhibition.

4. **LIQUOR POTASSII IODIDI COMPOSITUS**, L. *Compound Solution of Iodide of Potassium; Solution of Ioduretted Iodide of Potassium.*

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[z] *Essays*, p. 75.

(Iodide of Potassium, grs. x.; Iodine, grs. v.; Distilled Water, Oj. Mix, that they may be dissolved).—It is a brown-coloured solution, having the peculiar smell and taste of iodine. It may be diluted with water without suffering any change. It may be usefully employed in the diseases of children.—Dose for adults, from f℥ij. to f℥vj., or even beyond this.

Solutions of IODURETTED IODIDE OF POTASSIUM, of various strengths, have been employed for different purposes by Lugol[a]. The following are the most important:—

α. *Lugol's Concentrated Solution of Iodine in Iodide of Potassium* consists of Iodine, ℈j.: Iodide of Potassium, ℈ij.; Distilled Water, ℥vij. Mixed with 3 pints and 13 fluidounces of water, it forms a solution equal in strength to the ***Liquor Potassii Iodidi compositus*, L.**

β. *Lugol's Ioduretted Mineral Water* is prepared of three degrees of strength:—

	No. 1.	No. 2.	No. 3.
Iodine	gr. ¾	i	i¼
Iodide of Potassium	gr. i½	ii	ii½
Distilled Water	℥viii	℥viii	℥viii.

The solutions are yellowish or orange-coloured, and are quite transparent. When sweetened it is readily taken by children, but the sugar should be added at the time of administration, as in the course of a few hours it effects a chemical change in the solution. From six to eight ounces should be taken daily.

γ. *Lugol's Caustic, Rubefacient, and Stimulant Solutions*, are composed of the same ingredients, but in different proportions.

	Stimulating Washes.			Rubefacient Solution.	Caustic Solution.
	No. 1.	2.	3.		
Iodine	gr. ii.	gr. iii.	gr. iv.	ʒ iv.	℥ i.
Hydriodate Potash	gr. iv.	gr. vi.	gr. viii.	℥ i.	℥ i.
Distilled Water	lb. i.	lb. i.	lb. i.	℥ vi.	℥ ii.

Lugol uses the stimulating washes in scrofulous ulcers, ophthalmia, fistulous abscesses, &c. When the scrofulous surfaces require stronger excitement than usual, he employs the rubefacient solution. In tubercular tumors which have obstinately resisted all other forms of treatment, the rubefacient solution may be applied in admixture with linseed meal (forming the *ioduretted cataplasm* of Lugol). To prepare the mixture, the poultice is first made in the ordinary manner; and when moderately cool, a sufficient quantity of the rubefacient liquid is poured on it with a wooden measure. The caustic solution is used for touching the eyelids and nasal fossæ, to repress excessive granulations, &c.

δ. *Lugol's Ioduretted Baths.*—These are employed in the treatment of scrofula. They are to be made in wooden vessels.

IODURETTED BATHS FOR CHILDREN.				IODURETTED BATHS FOR ADULTS.			
Age.	Water.	Iodine.	Iodide of Potassium.	Degree.	Water.	Iodine.	Iodide of Potassium.
	(Quarts.)	(Troy Grains.)	(Troy Grains.)		(Qrts.)	(Drms. Troy.	(Drms. Troy.)
4 to 7	36	30 to 36	60 to 72	No. 1.	200	2 to 2½	4 to 5
7 „ 11	75	48 .. 60 .. 72	96 .. 120 .. 144	No. 2.	240	2 .. 2½ .. 3	4 .. 5 .. 6
11 „ 14	125	72 .. 96	144 .. 192	No. 3.	300	3 .. 3½	6 .. 7

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[a] Lugol's *Essays on the Effects of Iodine in Scrofulous Diseases;* translated by Dr. O'Shaughnessy, p. 167. Lond. 1831.

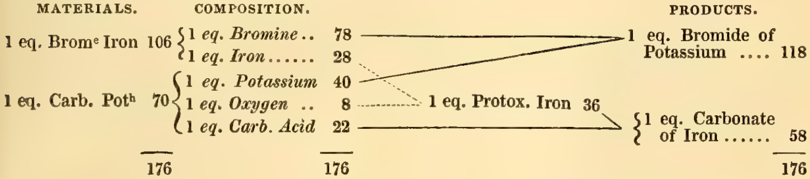
3. POTAS'SII BRO'MIDUM, *L.*—BROMIDE OF POTASSIUM.

History.—This salt, also called *hydrobromate of potash*, was first described by Balard in 1826 [b].

Preparation.—The *London College* direct it to be prepared as follows:—

Take of Bromine, ℥ij.; Carbonate of Potash, ℥ij. and ʒj.; Iron Filings, ℥j.; Distilled Water, Oiij. First add the Iron, and afterwards the Bromine, to a pint and a half of the distilled water. Set them by for half an hour, frequently stirring with a spatula. Apply a gentle heat, and when a greenish colour occurs, pour in the carbonate of potash dissolved in a pint and a half of water. Strain and wash what remains in two pints of boiling distilled water, and again strain. Let the mixed liquors be evaporated so that crystals may be formed.

In this process bromide of iron is first formed: this is afterwards decomposed by carbonate of potash, by which protocarbonate of iron and bromide of potassium are produced.



Another mode of procuring this salt is to mix bromine with a solution of caustic potash, by which bromide of potassium and bromate of potash are formed. The bromate of potash may be converted into bromide of potassium by heat or by hydrosulphuric acid (see *Iodide of Potassium*, p. 490).

Properties.—This salt crystallizes in whitish transparent cubes, or rectangular prisms. It is inodorous: its taste is pungent, saline, and similar to common salt, but more acrid. It is permanent in the air. When heated it decrepitates, and at a red heat fuses without suffering decomposition. It is very soluble in both cold and hot water, and slightly so in alcohol.

Characteristics.—That this salt is a *bromide* is known by the characters before mentioned (see p. 251) for this class of salts. That its base is potassium (or potash) is shewn by the tests already given for this substance (see p. 481).

Composition.—This salt consists of bromine and potassium in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Balard.*	*Liebig.*
Bromine	1	78	66·1	65·56	67·42
Potassium	1	40	33·9	34·44	32·58
Bromide of Potassium	1	118	100·0	100·00	100·00

The crystals may contain water lodged mechanically between their plates, but no combined water (water of crystallization).

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[b] *Ann. de Chim. et de Phys.* xxxii.

PURITY.—The purity and goodness of this salt may be known by the following characters:—The form of the crystals, their freedom from colour, and their neutrality with respect to litmus and turmeric. A solution of this salt should give no precipitate with chloride of barium, shewing the absence of carbonates and sulphates. The method employed by Rose[c] for detecting minute quantities of the chlorides in bromides, is the following:—If pure bromide of potassium mixed with excess of bicarbonate of potash be distilled with concentrated sulphuric acid in a tubulated retort, to which is adapted a receiver containing excess of solution of caustic ammonia, pure bromine distils over, and the ammoniacal liquor remains perfectly colourless. But if the bromide contained a chloride, both bromine and the chromate of chloride of chromium distil over, and the ammoniacal liquor becomes yellow: chromic acid may be detected in the solution by the usual tests.

The characters of good bromide of potassium are, according to the London College, as follows:—

> Totally dissolved by water. It does not alter the colour of litmus or turmeric. Chloride of barium throws down nothing from the solution. Sulphuric acid and starch added together render it yellow. Subjected to heat it loses no weight. Ten grains of this salt are capable of acting upon 14·28 grains of nitrate of silver, and precipitating a yellowish bromide of silver, which is dissolved by ammonia, and but very little by nitric acid.

If more nitrate of silver than the quantity above stated be decomposed by the bromide, the presence of a chloride may be suspected.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—The effects on plants have not been ascertained.

β. On Animals.—Thirteen grains of bromide of potassium dissolved in water, and injected into the jugular vein of a dog, coagulated the blood, caused convulsions and death, in a few minutes[d]. The same experimenter introduced a drachm of the salt into the stomach of a dog without any ill effects, save vomiting. But two drachms, and even a drachm and a half, killed dogs in three days, when retained in the stomach by a ligature of the gullet, with marks of inflammation in the gastro-intestinal membrane. Maillet[e] gave two ounces to a dog without any ill effect; and he observes, that according to the principle, that the dose of a saline substance for the horse should be eight times that for the dog, a pound of bromide of potassium would have no ill effect on horses.

γ. On Man.—The effects of bromide of potassium on man require further investigation. They appear to be analogous to those of iodide of potassium. Dr. Williams[f] gave five grains of this salt three times daily for fourteen months, without any injurious effect. I have given the same dose to a boy of about 14 years old, affected with enlarged spleen consequent on intermittent fever, for several weeks, without any marked effect. By the application of starch and a few drops of chlorine to the urine, a yellow bromide of starch was obtained, shewing the presence of a bromide in the urine. The case is now under treatment; but the volume of the spleen appears to be lessening.

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[c] *Journ. de Pharm.* t. 23, p. 489.

[d] Barthez, *Journ. de Chim. Méd.* t. 5^{me}, p. 214.

[e] *Journ. de Chim. Méd.* t. 3, 2^{e} Série, p. 225.

[f] *Elements of Medicine,* vol. i. p. 338.

In most cases it acts as a diuretic. In irritable conditions of the alimentary tube it is apt to occasion diarrhœa. Three cases are mentioned by Dr. Williams, in which, on account of this state of the bowels, more than four or five grains could not be exhibited at a time, and even then it was occasionally necessary to give opium. Under the continued use of it, enlargements of the spleen and liver, and swellings of the lymphatic glands, have disappeared; so that it appears to agree with iodine, mercury, and the alkalis, in being liquefacient and resolvent (see p. 194). Dr. Williams thinks that it possesses "unusual, if not specific, powers in the cure of diseases of the spleen."

USES.—In 1828, Pourché[g] employed this salt with benefit in the treatment of bronchocele and scrofula: it was taken internally, and applied externally in the form of ointment. In 1836 it was introduced into the London Pharmacopœia, in consequence of the great success obtained from the use of it in a case of enlarged spleen, under the care of Dr. Williams[h]. In this, and in three other successful cases of the same disease, it was used internally only. Dr. Williams also gave it with success in a case of ascites. Magendie[i] employs it as an anti-scrofulous remedy, as an emmenagogue, and against hypertrophy of the ventricles. Prieger[j] applied it externally in the form of ointment in tinea capitis.

ADMINISTRATION.—It is exhibited in the form of pill or solution in doses of from four to ten grains three times a day.

ANTIDOTES.—In a case of poisoning by this salt the treatment will be the same as for iodide of potassium.

UNGUENTUM POTASSII BROMIDI. *Ointment of Bromide of Potassium.*—This is composed of from ℈j. to ʒij. of bromide to ℥j. of lard. Bromine is sometimes added.

4. POTAS'SII SULPHURE'TUM, *L. E.*—SULPHURET OF POTASSIUM.

(Potassæ Sulphuretum, *D.*)

HISTORY.—Geber[k] was acquainted with the solubility of sulphur in an alkaline solution; but Albertus Magnus taught the method of procuring sulphuret of potassium by fusion. The preparation kept in the shops is a mixture of the sulphuret of potassium and sulphate of potash, and was formerly called *Sulphuret of Potash* or *Liver of Sulphur.*

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[g] *Journ. de Chim. Méd.* t. iv. p. 594.

[h] *Op. cit.*

[i] *Formulaire,* 8^{me} éd. 1835.

[j] Dierbach, *Die neusten Entdeck. in der Mat. Méd.* 1837.

[k] *Invention of Verity,* ch. vi.

Preparation.—The process for the preparation of this compound is the same in all the British pharmacopœias.

Take of Sulphur, ℥j.; Carbonate of Potass, ℥iv. Rub them together, and place them upon the fire, in a covered crucible, until they have united.

When sulphur and commercial carbonate of potash are fused together, water and carbonic acid are evolved. Part of the potash is decomposed; its potassium combining with sulphur to form a sulphuret of potassium; while its oxygen unites with sulphur to form one or more acids which combine with some undecomposed potash. A portion of the carbonate of potash remains undecomposed.

Properties.—When fresh prepared, it has a liver-brown colour; and hence its name *hepar sulphuris*. Its taste is acrid, bitter, and alkaline. If quite dry it is inodorous, but when moistened it acquires the odour of hydrosulphuric acid. Exposed to the air it undergoes decomposition, from the action of the aqueous vapour and oxygen. It becomes green and moist, and ultimately whitish. This change depends on the absorption of oxygen, in consequence of which part of the sulphur is deposited, while a portion of the sulphuret of potassium is converted into hyposulphite, afterwards into sulphite, and ultimately into sulphate of potash. Sulphuret of potassium is soluble in water.

Characteristics.—Hydrochloric acid causes the evolution of hydrosulphuric acid gas and the precipitation of sulphur; the solution of the sulphuret in water produces a reddish or black precipitate with a solution of lead. That it contains potassium may be determined thus:—Add excess of hydrochloric acid to a solution of it; boil, and filter. The before-mentioned tests for potash (see p. 481) may then be applied.

"Fresh broken it exhibits a brownish-yellow colour. Dissolved in water, or in almost any acid, it exhales a smell of hydrosulphuric acid. The aqueous solution is of a yellow colour. What is thrown down by acetate of lead is first red[kk], and it afterwards blackens." *Ph. L.*

Composition.—Berzelius[l] says, that if 100 parts of carbonate of potash be fused with 58·22 of sulphur, the product is a mixture of three equivalents of tersulphuret of potassium and one equivalent of sulphate of potash; and he adds, that if less than the above proportion of sulphur be employed, a portion of carbonate of potash remains undecomposed. But Winckler[m] has shewn, that if the carbonate employed be quite pure, and the operation be very carefully conducted, no sulphate is obtained, but hyposulphite and sulphite of potash. He fused together 900 grs. of crystallized basic carbonate of potash (dried at 212° F.) with 518 grs. of washed flowers of sulphur. The per-centage composition of the product was as follows:—

[kk] The precipitate with acetate of lead I find may be red, reddish-black, or black. The alkaline monosulphurets cause a black, the polysulphurets a red, precipitate with solutions of lead. (See *Hydrosulphuret of Ammonia*, p. 478.)

[l] *Traité de Chimie*, t. ii. p. 301. Paris, 1831.

[m] *Berliniches Jahrbuch*, Band. XLI. S. 321; 1839.—A corrected abstract of this paper is contained in the *Pharmaceutisches Central-Blatt für* 1839, S. 547.

Tersulphuret of Potassium	53·2905
Hyposulphite of Potash	29·4580
Sulphite of Potash	6·8613
Sulphate of Potash	0·7730
Carbonate of Potash	2·8780
Loss	6·7392
Hepar Sulphuris	100·0000

Physiological Effects. *a. On Vegetables.*—There can be no doubt but that this compound is a powerful poison to plants, though I am not acquainted with any experiments made with it.

β. On Animals generally.—From the experiments of Orfila[n] on dogs, sulphuret of potassium appears to be a powerful narcotico-acrid poison. Six drachms and a half, dissolved in water, and introduced into the stomach, caused convulsions and death in seven minutes.

γ. On Man.—In *small doses* (as from four to ten grains) it acts as a general stimulant; increasing the frequency of the pulse, augmenting the heat of the body, promoting the different secretions, more especially those of the mucous membranes, and sometimes exciting local irritation, marked by pain, vomiting, and purging. By continued use it acts as a resolvent or alterative; and, on this account, is employed in certain forms of inflammation.

In *large doses* it is an energetic narcotico-acrid poison. In two instances it proved fatal in fifteen minutes: the symptoms were, acrid taste, slight vomiting, mortal faintness, and convulsions, with an important chemical sign, the tainting the air of the chamber with the odour of hydrosulphuric acid[o].

Its local action is that of a powerful irritant: hence the acrid taste, burning pain, and constriction in the throat, gullet, and stomach, with vomiting and purging. But the nervous system also becomes affected; as is proved by the faintness, the almost imperceptible pulse, the convulsions, and (in some cases) sopor. These symptoms are analogous to those caused by hydrosulphuric acid; which, in fact, is copiously developed in the stomach.

Uses.—Internally, it has been administered in very obstinate skin diseases, such as lepra and psoriasis, which have resisted all the ordinary means of cure. It has also been employed as a resolvent in inflammations attended with lymphatic exudation, as croup, and in glandular enlargements. In chronic rheumatism, gout, hooping-cough, and various other diseases, against which it was formerly employed, it is now rarely if ever administered. It ought not to be given as an antidote for metallic poisoning, since it is itself a powerful poison.

Externally, it is applied in the form of lotions, baths, or ointment, in chronic skin diseases, such as eczema, scabies, lepra, &c.

Administration.—Internally it may be administered in the dose of three or four grains gradually increased. It may be given either in solution, or in the form of pill made with soap. For external use it is employed in solution in water, either as a bath or wash, or in the form of ointment. *Lotions* are sometimes made by dissolving an ounce of the sulphuret in two or three quarts of water. The *ointment* is composed of ʒss. of sulphuret to ℥j. of lard.

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[n] *Toxicologie Générale.*

[o] Christison, *Treatise on Poisons*, p. 228.

Antidotes.—In the event of poisoning by this substance, the antidote is a solution of chloride of soda, or of chloride of lime.

1. **SOLUTIO POTASSII SULPHURETI**; *Potassæ Sulphureti Aqua*, D. (Washed Sulphur, 1 part; Water of Caustic Potash, 11 parts. Boil during ten minutes, and filter through paper. Let the liquor be kept in well-closed vessels. The sp. gr. of this liquid is 1·117).—By the mutual reaction of sulphur and potassa, aided by the water and heat, a solution of sulphuret of potassium and hyposulphite of potash is obtained. The colour of this preparation is deep orange. It is sometimes administered in scabies, tinea capitis, and other allied eruptive diseases.—Dose, from ♏x. to fʒj., sufficiently diluted with water.

2. **BALNEUM SULPHURATUM**; *Sulphurated* or *Sulphurous Bath.* This is prepared by dissolving ℥iv. of sulphuret of potassium in 30 gallons of water (Rayer). It should be prepared in a wooden bathing vessel.—Used in obstinate skin diseases, as lepra and scabies. If an acid be added to this bath, sulphur is precipitated and sulphuretted hydrogen evolved. Care must be taken, lest asphyxia be produced by the inhalation of the latter.

3. **BALNEUM SULPHURATUM ET GELATINOSUM**; *Dupuytren's Gelatino-Sulphurous Bath.* This is prepared by adding one pound of Flanders glue (previously dissolved in water) to the sulphuretted bath above described.—It may be used as a substitute for the waters of Barèges; the glue representing the *Baregine*, an organic matter found in these waters. Barèges waters have been celebrated for cleansing foul ulcers, healing old wounds, and curing obstinate skin diseases.

5. POTAS'SÆ BISUL'PHAS, *L. E. D.*—BISULPHATE OF POTASH.

History and Synonymes.—The mode of preparing this salt was taught by Lowitz and Link, at the latter end of the last century. The salt has had various names, such as *Supersulphate of Potash*, *Sal Enixum*, *Acid Vitriolated Tartar*, and *Sal Auri Philosophicum.*

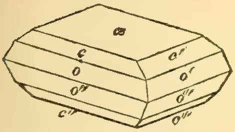
Preparation.—All the British Colleges give formulæ for the preparation of this salt.

The *London* and *Edinburgh Colleges* direct it to be prepared by adding sulphuric acid to a solution of the salt which remains after the distillation of [pure, *E.*] nitric acid. The London College uses lbij. of the salt, lbj. of sulphuric acid, and Ovj. of boiling water. The Edinburgh College employs the same quantity of salt and water, but only f℥vij. and ʒj. of acid.

The *Dublin College* prepares it from Sulphuric Acid of commerce, two parts; Carbonate of Potash, from Potashes, as much as may be sufficient; Water, six parts. Let one portion of the sulphuric acid, mixed with the water, be saturated by the carbonate of potash, then let another portion of the acid be added to the mixture. Let the liquor evaporate until, on cooling, crystals are formed.

The salt which remains in the retort after the preparation of the Acidum Nitricum, *L.* & *E.*, is bisulphate of potash. When "the solution is allowed to crystallize, it occasionally happens that some sulphate and sesquisulphate are mixed with the bisulphate, owing to the partition of the excess of sulphuric acid between the water and the sulphate of potash. This inconvenience is remedied by the addition of sulphuric acid now directed to be employed[p]."

Fig. 78.



Prism of Bisulphate of Potash.

Properties.—It is crystallizable; the crystals belong to the right prismatic system. It has a very acid taste, and reacts strongly as an acid on vegetable colours, and decomposes the carbonates with effervescence. It is soluble in about twice its weight of water at 60°. By a red heat it evolves sulphuric acid, and is converted into the neutral sulphate of potash.

Composition.—It consists of—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Geiger.*
Sulphuric Acid	2	80	54·80	54·77
Potash	1	48	32·87	32·53
Water	2	18	12·33	12·70
Crystallized Bisulphate Potash	1	146	100·00	100·00

Characteristics.—The presence of sulphuric acid may be recognised by the chloride of barium (see p. 469). When subjected to a red heat, bisulphate of potash loses half of its acid. The residue is the neutral sulphate; the potash of which may be detected by the characters already mentioned for this substance (see p. 481). From the neutral sulphate of potash it is distinguished by its acid taste, its action on litmus and on the alkaline carbonates, and by its greater solubility.

Physiological Effects and Uses.—It is rarely used as a medicine. It possesses the combined properties of sulphuric acid and sulphate of potash. The excess of acid renders its local operation that of an astringent. When swallowed it operates as a mild purgative, and may be employed in the same cases as the sulphate, over which it has the advantage of greater solubility. Conjoined with rhubarb it covers the bitter taste of the latter without injuring its medicinal properties. Dr. Barker[q] says it may be used to form a cheap effervescing purgative salt, as follows:—73 grains of bisulphate of potash and 72 grains of crystallized carbonate of soda, to be separately dissolved in two ounces of water, and taken in a state of effervescence.

Administration.—The dose of it is from gr. x. to ʒij. properly diluted.

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[p] Mr. R. Phillips, *Translation of the Pharmacopœia*, p. 295. 4th edit.

[q] *Observations on the Dublin Pharmacopœia*, p. 138. Dublin, 1830.

6. POTAS'SÆ SUL'PHAS, *L. E. D.*—SULPHATE OF POTASH.

History and Synonymes.—The mode of preparing this salt was taught by Oswald Croll, in 1643. It has been known by various appellations, such as *Specificum Purgans Paracelsi*, *Arcanum duplicatum*, *Vitriolated Kali*, *Vitriolated Tartar*, *Sal Polychrest* (literally signifying *salts of many uses* or *virtues*), *Sal de Duobus*, &c.

Natural History.—Sulphate of potash is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—It has been met with in small quantities in some mineral waters of Saxony and Bohemia, in native alum, in alum-stone, and in a mineral called *polyhalite*, in which Stromeyer found no less than 27·6 per cent. of the sulphate of potash.

β. In the Organised Kingdom.—It has been found in the root of Polygala Senega, Winter's bark, the bulb of garlic, myrrh, opium, &c. The blood and urine of man also contain it.

Preparation.—It is prepared from the residuum of the distillation of nitric acid.

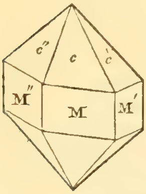
The *London College* orders of the salt which remains after the distillation of Nitric Acid, lbij.; Boiling Water, *Cong.* ij. Ignite the salt in a crucible until the excess of sulphuric acid is entirely expelled, then boil it in the two gallons of water until a pellicle floats, and the liquor being strained, set it aside that crystals may be formed. The liquor being poured off, dry them.

The *Edinburgh and Dublin Colleges* order the salt left after the distillation of nitric acid to be dissolved in water, and its excess of acid to be saturated. The Edinburgh College employs for this purpose white marble (carbonate of lime); while the Dublin College uses carbonate of potash. The neutral solution of sulphate of potash is then to be evaporated and crystallized.

The heat employed by the London College is to drive off the excess of sulphuric acid.

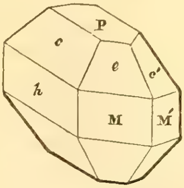
Properties.—It usually crystallizes in single or double six-sided pyramids. The two pyramids are sometimes united at a common base, or are separated by a short intervening prism (fig. 79). These forms agree very closely with those belonging to the rhombohedral

Fig. 79.



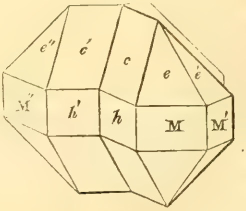
Common bipyramidal crystal.

Fig. 80.



Ditto modified.

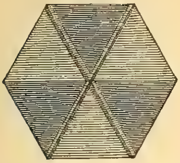
Fig. 81.



Compound crystal composed of three so united that their upper edges meet at angles of 120°.

system. But they have been shewn by Dr. Brewster[r] to be composite crystals; being composed of several crystals belonging to the right prismatic system, agglutinated so as to simulate the forms of the rhombohedral system. If a plate, cut perpendicular to the axis of the double pyramid, be examined by polarized light, it presents the tessellated structure shewn in fig. 82; and each of the six equilateral triangles are found to have two axes of double refraction.

FIG. 82.



Tessellated appearance of a plate of sulphate of potash seen by polarized light.

Crystals of sulphate of potash are hard, inodorous, have a saline bitter taste, and are unchanged by exposure to the air. When heated they decrepitate. At 60° F. they require sixteen times their weight of water to dissolve them: they are insoluble in alcohol. A solution of them is decomposed by tartaric acid, which forms crystals of bitartrate of potash.

Characteristics.—I have already stated these, when describing the bisulphate.

COMPOSITION.—The crystals contain no water of crystallization. They are thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wenzel.*
Sulphuric Acid	1	40	45·45	45·25
Potash	1	48	54·55	54·75
Sulphate of Potash	1	88	100·00	100·00

PHYSIOLOGICAL EFFECTS.—It acts as a very mild purgative, without occasioning any heat, pain, or other symptoms of irritation. Its operation is, in fact, too mild for ordinary use.

USES.—It is particularly serviceable as a laxative in disordered conditions of the alimentary canal, as diarrhœa and dyspepsia, in hepatic disorders, and in hemorrhoidal affections. It is best given in combination with rhubarb. Thus, from five to ten grains of rhubarb, with from fifteen grains to two drachms of this salt, will be found to act mildly and efficiently in many cases of dyspepsia and diarrhœa. It is an excellent aperient for children. The objections to its employment are its slight solubility, and that when given in large doses to children it is apt to produce vomiting. It is useful, on account of its hardness, for triturating and dividing powders, as in the *pulvis ipecacuanhæ compositus*. Its powder is an excellent dentifrice: the only objection to its use is its taste.

DOSE.—It is given in doses of from fifteen grains to four or five drachms.

POTASSÆ SULPHAS CUM SULPHURE, E.; *Sal Polychrestum Glaseri; Glaser's Sal Polychrest.* (Nitrate of Potash, and Sulphur, equal parts; mix them thoroughly; throw the mixture, in small successive portions, into a red-hot crucible; and when the deflagration is over, and the salt has cooled, reduce it to powder, and preserve it in well-closed bottles).—The sulphur is oxidized at the expense of the oxygen of the nitric acid, and the resulting compound consists principally of sulphate of potash, mixed probably with some sulphite; but the precise nature of the compound has not been carefully determined. Dr. Duncan[s] says "that in its medical effects and exhibition it agrees with the sulphureous mineral waters, which contain a portion of neutral salt."—Dose, ʒss. to ʒj.

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[r] *Edinburgh Philosophical Journal*, vol. i. p. 6. Edinb. 1819.—See also Mr. W. Phillips, *Annals of Philosophy*, N. S. vol. iv. p. 342, Lond. 1822; Levy, *Quarterly Journal of Science*, vol. xv. p. 285, Lond. 1823; and Mr. Brookes, *Ibid.* N. S. vol. vii. p. 20, 1824.

7. POTAS′SÆ NI′TRAS, *L. E. D.*—NITRATE OF POTASH.

History.—At what time this salt became known is difficult now to determine. As it is found in various parts of the East, on the surface of the earth, it appears probable that it must have been known at a very early period. Furthermore, if the Chinese and Hindoos were acquainted with the art of making gunpowder and fireworks at a very early period of history, they must have employed, and, therefore, been acquainted with, nitre. Geber[t], however, is the first who distinctly mentions it. He describes the mode of making nitric acid from it. But the terms *neter* of the Old Testament[u], translated *nitre*,—*νίτρον* of Herodotus[v] and Theophrastus[w]—and *nitrum* of Pliny[x], appear to have been applied either partially or exclusively to *natron*[y]. The word *saltpetre*, usually applied to nitre, is evidently derived from *sal petræ*, literally signifying rock salt[z].

Natural History.—This salt occurs in both kingdoms of nature.

α. In the Inorganised Kingdom.—In the East Indies, Egypt, Persia, Spain, and other parts of the world, large quantities of nitre are found in the soil. It would appear to be formed below, and to be brought to the surface of the soil by efflorescence. It has been usually supposed that the nitric acid was formed by the direct union of the nitrogen and oxygen of the air; but there are no facts which justify this opinion. It is much more probable that it is formed by the oxidation of ammonia (which is a constant constituent of the atmosphere); the products being nitric acid and water. The simultaneous oxidation of hydrogen is necessary to effect the union of oxygen with nitrogen. The cause of this is that the acid and water unite, so that water may be said to be a condition of *nitrification*[a]. Azotised animal matter is no further necessary than as yielding ammonia. In a nitre-cave in Ceylon, Dr. Davy[b] found nitre without animal matter. The potash of the nitrate is in most cases easily accounted for, being found in some of the constituents of the soil, as feldspar and mica.

β. In the Organised Kingdom.—This salt has been found in various plants, as in the roots of *Cissampelos Pareira, Geum urbanum*, &c.[c]

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[s] *Edinburgh Dispensatory.*

[t] *Invention of Verity*, ch. xxiii.

[u] *Proverbs*, ch. xxv. 20; *Jeremiah*, ch. ii. 22.

[v] *Euterpe*, lxxxvii.

[w] *De Igne.*

[x] *Hist. Nat.* xxx. i.

[y] See Beckman's *History of Inventions and Discoveries*, vol. iv.

[z] See *Sodæ Carbonas* and *Sodæ Sesquicarbonas*.

[a] Liebig, *Organic Chemistry in its Application to Agriculture and Physiology*, edited by L. Playfair. Lond. 1840.

[b] *Account of the Interior of Ceylon.*

[c] De Candolle, *Phys. Végét.* p. 387.

Extraction.—The nitrate of potash consumed in this country is imported from India, where it is obtained from natural sources. In some parts of Europe it is obtained artificially.

The district of Tirhût, in Bengal, is more productive of nitre than any other place in India. It is most abundant in those parts containing a redundancy of carbonate of lime. An average sample of the soil analyzed by Mr. Stevenson[d] gave the following composition:—

Matter insoluble in three Mineral Acids	Silex	50·0
Matter soluble in ditto	Carbonate of Lime	44·3
Matter soluble in Water	Sulphate of Soda	2·7
	Muriate of ditto	1·4
	Nitrate of Lime	0·9
	Nitrate of Potash	0·7
		100·0

"In the month of November the *leonahs*, or native manufacturers of saltpetre, commence their operations, by scraping off the surface from old mud heaps, mud buildings, waste grounds, &c. where the saltpetre has developed itself in a thin white efflorescence, resembling frost rind. This saline earth being collected at the factories, the operator first subjects it to the process of solution and filtration. This is effected by a large mud filter, lined on the inside with stiff clay." It has a false bottom of bamboo, covered with close wrought grass mats, on which are placed vegetable ashes. Upon these the nitrous earth is laid. Water is then added to dissolve the saline matters of the earth, and the solution thus obtained, filtering through the mats, drops into the empty space between the real and false bottom, and is conveyed away into an earthen receiver. In its passage through the wood-ashes the carbonate of potash contained in the latter reacts on the nitrate of lime of the solution, and produces nitrate of potash and carbonate of lime. The solution is afterwards evaporated in earthen pots, filtered, and put aside to crystallize. The impure nitre thus procured is termed *dhouah:* it contains from 45 to 70 per cent. of pure nitrate of potash. It is re-dissolved and crystallized by the native merchants, who supply the Calcutta bazaars, and when thus purified is called by the natives *kalmee*[e].

Rough Nitre.—Saltpetre is imported into this country principally from Calcutta, but some comes from Madras. It is brought over in cloth bags, which contain from 150 to 175 lbs. each. Its quality varies considerably. It is always more or less impure: but the common varieties, which have a dirty yellowish appearance, are termed *rough* or *crude saltpetre*, or *grough petre*, while the purer and cleaner looking kinds are called *East India refined*. The loss which it suffers in refining, or, in other words, the impurities which it contains, are technically designated *refraction*. This varies greatly in different samples, but is usually between 5 and 15 per cent.[f]

Purification.—Refined rough nitre is purified by dissolving it in water, boiling the solution, removing the scum, and, after the liquid has been allowed to settle, it is strained, while hot, through a hempen cloth, and set aside to crystallize. At the Waltham Abbey powder-mills the crystallization is effected in copper pans. When it has been dissolved and crystallized once only it is called *singly refined nitre:* when twice, *doubly refined*[g]. Its purity may be ascertained by testing it with nitrate of silver, chloride of barium, and oxalate of ammonia. The first detects the chlorides, the second the sulphates, and the third the calcareous salts.

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[d] *Journ. of the Asiatic Society of Bengal*, vol. ii. p. 23.

[e] See Stevenson, *op. cit.*; also *India Journal of Med. and Phys. Science*, new series, vol. i. p 10. 1836.

[f] For the methods of determining it, consult Dumas, *Traité de Chimie*, t. 2^{me}, p. 762; Brande's *Manual of Chemistry*, 4th ed. p. 549.

The *Dublin College* orders *Purified Nitrate of Potash* (*Potassæ Nitras purificatum*) to be thus prepared: Take of Nitrate of Potash, *one part.* Dissolve in two parts of hot water, filter the liquor, and set it aside, that, on cooling, crystals may be formed.

NITRE FROM ARTIFICIAL SOURCES.—The artificial preparation of nitre is practised in several parts of Europe. The establishments in which it is carried on are called *Artificial Nitrières*[h]. The mode adopted varies, however, in different places.

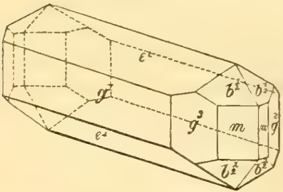
At Appenzel, a canton in Switzerland, nitre is formed from the urine of animals. A hole is dug near to stables, and in this is put a sandy kind of earth, which is kept moistened with the water running from the stables. In two or three years this earth yields nitre.

In Sweden[i], where each landed proprietor is compelled to furnish a certain quantity of nitre, it is prepared as follows:—Decomposing animal and vegetable matters, mixed with cinders, lime, or marl, are placed in heaps (called *nitre beds*) under cover, the mass being occasionally moved, or holes made in it, so that they are exposed to the air. From time to time they are watered with urine. At the end of two or three years the nitrogen has combined with oxygen, and this with bases to form nitrates. By lixiviation the salts may be separated, and any nitrate of lime present may be converted into nitrate of potash by adding wood-ashes, which contain carbonate of potash.

In Prussia *nitre-walls* are employed instead of nitre-beds. These have two advantages,—they economize land, and they expose a large surface to the air[k].

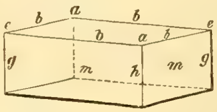
PROPERTIES.—Nitrate of potash usually crystallizes in the form of

FIG. 83.



Crystal of Nitre.

FIG. 84.



Primitive right rhombic prism.

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[g] Colonel Moody informs me that the rough nitre now supplied to the Waltham Abbey powder-mills has about 3 per cent. refraction, and requires one crystallization only to render it sufficiently pure for the manufacture of gunpowder.

[h] For full details of this process consult Thénard, *Traité de Chimie*, t. iii. p. 239, 5me éd. Paris, 1827; Dumas, *op. supra cit.*; and Kuhlmann, *Mém. Acad. Sciences de Lille*, 1838, and in Liebig's *Annalen*, xxix. 272.

[i] Berzelius, *Traité de Chimie*, t. iii. p. 391.

[k] Dumas, *op. cit.*

a six-sided prism with diëdral summits, which belongs to the right prismatic system[1]. It has, therefore, two axes of double refraction, and presents a double system of rings in polarized light (see figs. 35 and 36, p. 164). When pure the crystals are transparent and colourless, have a sharp cooling taste, and undergo no change by exposure to the air. When heated, nitrate of potash fuses, and when cast in moulds forms the *Nitrum Tabulatum*, or, from its having formerly been cast into small balls, and stained of a plum colour, *Sal Prunelle*. At a strong red heat it is decomposed, with the evolution of oxygen and the formation of hyponitrite of potash, which, when rubbed to powder and mixed with sulphuric acid, emits red fumes (composed of nitrous acid and binoxide of nitrogen). One hundred parts of water at 32° dissolve 13·32 parts of this salt, but at 77° they dissolve 38 parts. During the solution cold is generated. In pure alcohol nitre is insoluble.

Characteristics.—This salt is known to be a nitrate by the characters already detailed (p. 289) for this class of salts. That its base is potash is shewn by the tests before mentioned (p. 481) for this substance.

COMPOSITION.—Nitrate of potash has the following composition:—

	Atoms.	*Eq.Wt.*	*Per Ct.*	*Wollaston.*
Nitric Acid	1	54	52·9	53·332
Potash	1	48	47·1	46·668
Nitrate of Potash	1	102	100·00	100·000

	Atoms.	*Eq.Wt.*	*Per Ct.*
or Nitrogen	1	14	13·75
Oxygen	6	48	47·10
Potassium	1	40	39·15
	1	102	100·00

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Nitrate of potash dissolved in 300 times its weight of water promotes vegetation: but a solution containing $\frac{1}{30}$ part of nitre is injurious to the growth of plants[m].

β. On Animals generally.—Orfila[n] found that when introduced into the stomach of dogs it acts as an irritant poison. If administered in doses of two or three drachms, it is capable, when not vomited up, of causing death. Its operation is that of a narcotico-acrid poison. When applied to the cellular tissue it produces, according to this experimentalist, local effects only, and does not become absorbed. But Devergie[o] states, on the authority of J. E. M. Smith, that half an ounce applied to the thigh killed a dog in thirty-six hours. Eight ounces dissolved in a pint of water, and swallowed, killed a horse in twenty-four hours with all the symptoms of violent intestinal irritation[p]. Veterinarians use nitre as a diuretic and refrigerant in doses of from two to four drachms.

γ. On Man.—In *very large doses* (such, for example, as one ounce or more) nitre has in several instances caused death; but the effects of it are not uniform, since, in other cases, this quantity has not appeared to have any very remarkable or obvious effect. For example, Dr. Christison knew an instance in which one ounce was taken without occasioning any other unpleasant symptom than vomiting; and it was retained on the stomach for above a quarter of an hour. In those cases where violent effects followed the ingestion of it, the symptoms were twofold: on the one hand, those indicating inflammation of the alimentary canal (such as pain, vomiting, and purging); on the other hand, an affection of the nervous system (marked by giddiness, convulsions, failure of pulse, tendency to fainting, dilated pupil, insensibility, and palsy). It is probable that the operation of nitre is influenced by the quantity of aqueous liquid in which the salt is dissolved, and that the more we dilute, the less powerfully does it act as a poison. In no other way can we reconcile the discrepant statements in regard to the effects produced by an ounce of nitre.

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[1] Levy, *Quarterly Journal of Science*, vol. xv. p. 284; also Miller, in *Philosophical Magazine*, for July, 1840.

[m] Davy, *Agricultural Chemistry.*

[n] *Toxicol. Générale.*

[o] *Médecine Légale.*

[p] Moiroud, *Pharmacologie Vétérinaire.* Paris, 1831.

If nitre (or any other neutral alkaline salt) be mixed with dark-coloured venous blood out of the body, it communicates to it a florid or arterial hue. Now as this salt, when taken into the stomach, becomes absorbed, it is not unreasonable to suppose that while mixed with the circulating blood it might have an analogous effect. Dr. Stevens[q] asserts, that in the last stage of fever, when the blood is black, it has this effect. Moreover, he tells us (p. 154), that in a case which occurred in America, where a person swallowed an ounce of nitre, by mistake, in place of Glauber's salts, the blood when drawn from a vein was completely florid, and remained as fluid as if the nitre had been added to it out of the body[r].

In *moderate doses* nitre acts as a refrigerant, diuretic, and diaphoretic. Its refrigerant properties are best seen when the body is preternaturally hot, as in febrile disorders. Mr. Alexander[s], in his trials with it, made on himself, experienced a sensation of chilliness after each dose, but he could not recognise by the thermometer any diminution of heat in the external parts of his body. He found, in most of his experiments, that it had a powerful influence over the vascular system, and surprisingly diminished, in a very short period of time, the number of pulsations. Thus, on several occasions, a drachm of this salt, within a few minutes, reduced the frequency of the pulse from 70 to 60 beats. Sundelin[t] says nitre diminishes the orgasm and plasticity of the blood, perhaps by a chemical action on the cruor and fibrin. Diuresis is another, and very generally observed effect. As the nitre can be detected in the urine, its operation as a diuretic depends, perhaps, on the local stimulus which is communicated to the renal vessels while the salt is passing through them. Like most of the neutral salts of the alkalis, the continued use of it promotes alvine evacuations. Full doses frequently produce pain in the stomach. As a diaphoretic it is usually given in combination with emetic tartar.

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[q] *Observations on the Blood*, p. 298. Lond. 1832.

[r] For some remarks on the effects of nitre on the blood, by Mr. Carlyon, see *Lond. Med. Gaz.* vol. viii. p. 626; and on nitre as a therapeutic agent, by Dr. Hancock, see *Lancet* for 1831-2, vol. ii. p. 766.

[s] *Essays*, pp. 105, *et seq.* Edinb. 1768.

[t] *Heilmittell.* Bd. i. S. 59.

Uses.—It follows, from what has been now stated in regard to the physiological effects of nitre, that this substance is indicated when we wish to diminish preternatural heat, and to reduce the force and frequency of the pulse, as in febrile disorders, inflammatory affections, (except, perhaps, those of the stomach, bowels, kidneys, and bladder), and hemorrhages[t] (especially hemoptysis). In continued fever it is frequently given in combination with emetic tartar, and sometimes also with calomel. It is not often used as a diuretic, because its activity in this respect is not very great; but it is adapted for those cases which are accompanied with arterial excitement. In sore throat it is mixed with white sugar, and gradually swallowed. A mixture of nitre and powdered gum has long been a favourite remedy for diminishing the scalding of gonorrhœa. Nitre is rarely employed as an external agent, except as a means of producing cold. Thus, five ounces of nitrate of potash, with five ounces of muriate of ammonia, dissolved in sixteen ounces of water, reduces the temperature 40° F.; that is, from 50° to 10°, according to Mr. Walker. Hence, therefore, we sometimes employ this mixture, placed in a bladder, as an external application (see p. 33).

On the belief that fever, cholera, and other malignant diseases, were produced by a deranged state of the blood, and that this derangement depended on, or consisted in, a diminution or entire loss of the saline parts of the blood, Dr. Stevens employed nitre, chloride of sodium, and other alkaline salts, in the treatment of these diseases[u]. Nitre, in large doses, has been employed in the treatment of scurvy, and with considerable success, according to the statement of Mr. Cameron[v].

Administration.—It may be given in doses of from ten grains to half a drachm, in the form of powder, mixed with sugar, or in solution. If administered as a refrigerant, it should be dissolved in water and immediately swallowed, in order that the coldness of the solution may assist the action of the salt. If employed as a diuretic, we ought to give mild liquids plentifully, and keep the skin cool.

Antidote.—No chemical antidote for this salt is known. In case of poisoning, therefore, we should remove the poison from the stomach as speedily as possible, and administer tepid emollient drinks. Opiates, perhaps, may be advantageously administered. The inflammatory symptoms are to be combated by the usual antiphlogistic measures.

8. POTAS'SÆ CHLO'RAS, *L.*—CHLORATE OF POTASH.

History.—Chlorate of potash (also called *oxymuriate* or *hyperoxymuriate of potash*) was first procured by Mr. Higgins, who seems to have confounded it with muriate of potash. In 1786 it was distinguished by Berthollet.

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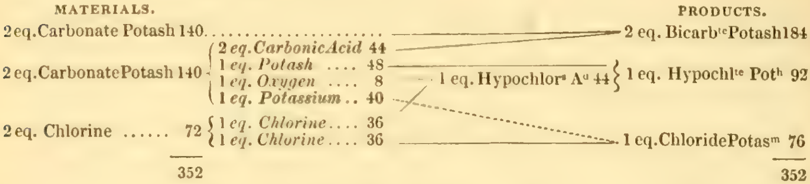
[t] Gibbons, *Medical Cases and Remarks*, Part II. *On Nitre in Hæmorrhagy*, 2d ed. Sudbury, 1811.
[u] *Op. supra cit.* pp. 296, 298, &c.
[v] *Medico-Chirur. Review*, March, 1830, p. 483.

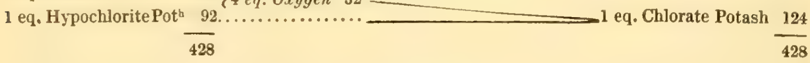
Preparation. — It is prepared by passing chlorine gas slowly through a cold solution of carbonate of potash placed in a Woulfe's bottle. The liquid is allowed to stand for twenty-four hours in a cool place, and is then found to have deposited crystals of chlorate of potash. These are to be drained, washed with cold water, dissolved in hot water, and re-crystallized.

When chlorine gas comes in contact with a solution of carbonate of potash, three salts are formed: chloride of potassium, hypochlorite of potash, and bicarbonate of potash.



In proportion as the quantity of chlorine increases, the bicarbonate becomes decomposed: carbonic acid is evolved, and a further quantity of hypochlorite of potash and chloride of potassium is produced. By the reaction of the carbonic acid on some hypochlorite of potash, a portion of hypochlorous acid is set free, which gives the liquor a yellow tinge[w].

When the solution is strongly charged with hypochlorite, the action of the chlorine on the potash is somewhat changed: it abstracts the potassium from the potash, and thereby forms chloride of potassium, while the oxygen thus set free combines with some hypochlorite of potash, and thereby converts it into the chlorate, the greater part of which crystallizes.


MATERIALS.
PRODUCTS.
4 eq. Chlorine........ 144
4 eq. Chlorde Potassium 304
4 eq. Potash.......... 192
4 eq. Potassm 160
4 eq. Oxygen 32
1 eq. Hypochlorite Poth 92
1 eq. Chlorate Potash 124
428
428

The residual liquor contains a little chlorate, some free hypochlorous acid, and a considerable quantity of hypochlorite of potash and chloride of potassium.

The preceding process is attended with some practical difficulties, to obviate which Professor Graham[x] recommends that carbonate of potash be mixed intimately with an equivalent quantity of dry hydrate of lime, and the mixture exposed to chlorine gas: the products are carbonate of lime, chlorate of potash, and chloride of potassium.

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[w] Delmar, in *Lond. Edinb. and Dubl. Phil. Mag.* for June, 1841, p. 422.

[x] *Proceedings of the Chemical Society*, No. 1.

PROPERTIES.—Chlorate of potash crystallizes in nearly rhomboidal plates belonging to the oblique prismatic system. Its taste is cool, and somewhat similar to nitre. When rubbed in the dark it becomes luminous. 100 parts of water at 32° F. dissolve 3·5 parts of chlorate: at 59° F. 6 parts: at 120° F. 19 parts.

Characteristics.—This salt is known to be a chlorate by the following characters:—When heated, it fuses, gives out oxygen, and is converted into chloride of potassium: when thrown on a red-hot coal it deflagrates—a property, however, common to several other salts. Sulphuric acid gives it an orange-red colour, evolves chlorous acid (peroxide of chlorine), known by its yellow colour, and great explosive power when heated. Rubbed with sulphur or phosphorus it explodes violently. Mixed with hydrochloric acid and then with water, it forms a bleaching liquid. The base of the salt is known to be potash, by the tests for this substance already mentioned (see p. 481).

COMPOSITION.—It is an anhydrous salt.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Chloric Acid	1	76	61·30	61·5083
Potash	1	48	38·70	38·4917
Chlorate of Potash	1	124	100·00	100·0000

IMPURITY.—Chloride of potassium is the usual impurity. This may be detected by a solution of nitrate of silver producing a white precipitate (*chloride of silver*). Pure chlorate of potash undergoes no obvious change on the addition of nitrate of silver to its solution.

PHYSIOLOGICAL EFFECTS. *a. On Animals generally.*—In one series of experiments, Dr. O'Shaughnessy[y] injected from 10 to 60 grains of chlorate of potash, dissolved in three ounces of tepid water, into the cervical vein of a dog: no ill effect was observed; the pulse rose in fulness and frequency, the urine was found in a short time to contain traces of the salt, and the blood of the tracheal veins had a fine scarlet colour. In another series of experiments the animal was stupified by hydrocyanic acid or hydrosulphuric acid gas: the brachial vein was opened, and a few drops of excessively dark blood could with difficulty be procured. Half a drachm of the chlorate dissolved in water of the temperature of the blood was injected slowly into the jugular vein: the pulsation of the heart almost immediately began to return, and in the course of eight minutes scarlet blood issued from the divided brachial veins. In twenty minutes the animal was nearly recovered, and passed urine copiously, which was found to contain the chlorate.

β. On Man.—The action of this salt on man requires further investigation. It appears to be refrigerant and diuretic, analogous to nitrate of potash. Wöhler and Stehberger have recognised chlorate of potash in the urine of patients to whom it had been exhibited, so that it does not appear to undergo any chemical change in its passage through the system. This fact is fatal to the hypothesis of the chemico-physiologists, who fancied that it gave oxygen to the system, and was, therefore, well adapted for patients affected with scorbutic conditions, which were supposed to depend on a deficiency of this principle. Excessive doses of the chlorate, like those of the nitrate, would probably produce an affection of the nervous system; but I am not acquainted with any satisfactory case in proof. Duchateau[z] says that 18 grains taken at thrice caused convulsions and delirium; but the observation is probably erroneous; for others have not experienced these effects from much larger doses. Dr. Stevens[a] says chlorate of potash gives a beautiful arterial colour to the venous blood, and reddens the gums much faster than mercury.

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[y] *Lancet* for 1831-2, vol. i. p. 369.

Uses.—Chlorate of potash was originally employed as a medicine for supplying oxygen to the system, where a deficiency of that principle was supposed to exist. With that view it was successfully administered by Dr. Garnett[b] in a case of chronic scorbutus. Dr. Ferriar also tried it in scurvy with success[c]. It was subsequently applied in the venereal disease and liver complaints as a substitute for mercurials, whose beneficial effects were thought to depend on the oxygen which they communicated to the system[d]. It has also been tried in cases of general debility, on account of its supposed tonic effects, but failed in the hands of Dr. Ferriar[e]. In a case of dropsy under the care of the latter gentleman, it operated successfully as a diuretic. More recently, it has been used by Dr. Stevens[f] and others, as a remedy for fever, cholera, and other malignant diseases, which, he supposes, depend on a deficiency of saline matters in the blood; but as it is usually employed in conjunction with common salt (see *Chloride of Sodium*) and carbonate of soda, it is impossible to determine what share the chlorate had in producing the beneficial effects said to have been obtained by what is called the *saline* treatment of these diseases. Köhler[g] tried it in phthisis, without experiencing benefit from it.

It appears, then, that most of the uses of this salt have been founded on certain views of chemical pathology, some of which are now considered untenable. It is very desirable, therefore, that some person, unbiassed by theoretical opinions, would carefully investigate its effects and uses, which I am inclined to think have been much overrated.

Administration.—The usual dose of it is from ten or fifteen grains to half a drachm. Dr. Wittman, in one case, gave 160 grains daily, with a little hydrochloric acid immediately after it, to decompose it: the effects were hot skin, headache, quick, full, and hard pulse, white tongue, and augmentation of urine.

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[z] Mérat and De Lens, *Dict. Mat. Méd.*

[a] *On the Blood*, p. 155.

[b] Duncan's *Annals of Medicine*, 1797.

[c] *Med. Hist. and Reflect.* vol. iii. p. 250.

[d] See the Reports of Mr. Cruikshank and Dr. Wittman, in Dr. Rollo's *Cases of Diabetes Mellitus*, 2d edit. pp. 504 and 563: also, Dr. Chisholm's Letter in the same work, *Preface*, p. x.

[e] *Op. cit.*

[f] *Op. supra cit.* p. 296.

[g] *Lancet* for 1836-7, vol. i. p. 33.

9. POTAS'SÆ CAR'BONAS, *L. E. D.*—CARBONATE OF POTASH.

History.—It is probable that the ancient Greeks, Romans, and Egyptians, were acquainted with this salt. Pliny[h] describes some of the uses of wood-ashes, and mentions a lye of them (*cinis lixivius*). For a long period carbonate of potash was confounded with carbonate of soda. Geber[i], in the eighth century, describes the method of procuring it by the combustion of tartar. It has been known by various names: such as, *Salt of Tartar*, *Mild Vegetable Alkali*, *Fixed Nitre*, and *Subcarbonate of Potash.*

Natural History.—Reuss[j] found carbonate of potash in the waters of the Wuissokow, and in the chalybeate of Twer.

It is formed, during the combustion of inland plants, by the decomposition of the vegetable salts of potash (the acetate, the malate, and the oxalate, but principally the first). Hence it is procured in great abundance from wood-ashes. In some few cases it has been supposed to exist ready formed in plants, as in a fern referred to by Mr. Parkes[k], the expressed juice of which is employed by the poor weavers of Yorkshire, in the cleansing of cloth at the fulling-mills.

Preparation. *α.* **Of Potashes and Pearlashes.**—It is principally obtained from *Wood-ashes* (*Cineres Vegetabilium*, seu *Cineres e Lignis combustis*). These are procured by burning wood piled in heaps on the ground, sheltered from the wind, or in pits[l]. The soluble constituents of the ashes are, *carbonate, sulphate, phosphate, and silicate of potash, and chlorides of potassium and sodium.* The insoluble constituents are, *carbonate and subphosphate of lime, alumina, silica, the oxides of iron and manganese, and a dark carbonaceous matter.* In America the ashes are lixiviated in barrels with lime, and the solution evaporated in large iron pots or kettles, until the mass has become of a black colour, and of the consistence of brown sugar. In this state it is called by the American manufacturers *Black Salts* (*Cineres clavellati crudi*). The dark colour is said by Dumas to be owing to *ulmate of potash.*

To convert this substance into the *Potashes* of commerce (*Cineres clavellati calcinati*), it is heated for several hours, until the fusion is complete, and the liquid becomes quiescent. It is then transferred by large iron ladles into iron pots, where it congeals in cakes. These are broken up, packed in tight barrels, and constitute the Potashes of commerce. Its colour varies somewhat, but it is usually reddish, in consequence of the presence of sesquioxide of iron.

To make the substance called *Pearlash* (*Potassa impura*, Ph. L.; *Lixivus Cinis*, Ph. D.) the mass called black salts, instead of being fused, is transferred from the kettles to a large oven-shaped furnace, constructed so that the flame is made to play over the alkaline mass, which in the meantime is stirred by means of an iron rod. The ignition is in this way continued until the combustible impurities are burnt out, and the mass, from being black, becomes dirty bluish white: this is pearlash[m]. The colouring matter is probably manganesiate of potash.

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[h] *Hist. Nat.* lib. xiv. and xxviii.

[i] *Invent. of Verity*, ch. iv.

[j] Gairdner, *On Mineral Springs*, p. 18.

[k] *Chemical Essays*, vol. ii. p. 17.

[l] For an account of the proportion and composition of wood-ashes, see Berthier, *Traité des Essais*, t. 1er, p. 259. Paris, 1834.

The following table shows the composition of various kinds of potash and pearlash, according to Vauquelin[n]:—

Kinds of Potash.	Caustic Hydrate of Potash.	Sulphate of Potash.	Chloride of Potassium	Insoluble residue.	Carbonic Acid and Water.
American Potash	857	154	20	2	119
Russian Potash	772	65	5	56	254
American Pearlash ..	754	80	4	6	308
Potash of Trèves	720	165	44	24	199
Dantzic Potash	603	152	14	79	304
Potash of Vosges	444	148	510	34	16

In this table it will be observed, that the American potash contains the largest quantity of caustic potash: this arises, probably, from the use of lime in its manufacture. Moreover, pearlash contains more carbonate of potash than potashes: this must arise from the absorption of carbonic acid during its preparation[o]. The potash and pearlash employed in this country are principally imported from the British North American colonies, from Russia, and from the United States of America.

β. **Of Refined Potashes**; *Potassæ Carbonas*, L. E.; *Potassæ Carbonas e Lixivo Cinere*, D.—The London and Dublin Colleges give directions for the preparation of this substance.

The *London College* orders of impure Carbonate of Potash, lbij.; Distilled Water, Oiss. Dissolve the impure Carbonate of Potash in the water, and strain; then pour it into a proper vessel, and evaporate the water, that the liquor may thicken; afterwards stir it constantly with a spatula until the salt concretes.

The *Dublin College* directs of Pearlash, in coarse powder, of Cold Water, of each, *one part*. Mix, by rubbing them together, and macerate during a week in any open vessel, occasionally shaking the mixture. Then filter the lixivium, and let it evaporate to dryness in a perfectly clean silver or iron vessel. Towards the end of the evaporation let the saline mass be continually stirred with an iron rod. Thus reduced to a coarse powder, let it be laid by in close vessels. If the Potashes be not sufficiently pure, before they are dissolved, let them be roasted in a crucible until they become white.

By the above proceedings the earthy impurities, insoluble in water, are got rid of.

γ. **Of Pure Carbonate of Potash**; *Potassæ Carbonas purum*, E.; *Potassæ Carbonas e Tartari Crystallis*, D.—All the British Colleges give directions for the preparation of this substance.

The *London College* states that Carbonate of Potass may be prepared more pure from the crystals of Bicarbonate of Potash, heated to redness.

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[m] *United States Dispensatory.*

[n] *Ann. de Chim.* xl. 273.

[o] For the mode of estimating the quantity of alkali present, see Mr. Faraday's *Chemical Manipulation*, art. *Alkalimetry*; also, Brande's *Manual of Chemistry*, 5th edit.

The *Edinburgh College* observes, that Pure Carbonate of Potash may be most readily obtained by heating crystallized Bicarbonate of Potash to redness in a crucible, but more cheaply by dissolving Bitartrate of Potash in thirty parts of boiling water, separating and washing the crystals which form on cooling; heating those in a loosely-covered crucible to redness so long as fumes are discharged; breaking down the mass and roasting it in an open crucible for two hours, with occasional stirring, lixiviating the product with distilled water, filtering the solution thus obtained, evaporating the solution to dryness, granulating the salt towards the close by brisk agitation, and heating the granular salt nearly to redness. The product of either process must be kept in well-closed vessels.

The process of the *Dublin College* is as follows:—Take of Crystals of Tartar any required quantity; heat them to redness in a silver crucible lightly covered, until they cease to emit vapours. Let the residue be reduced to a coarse powder, and roasted in the same crucible without a cover, with frequent stirring, during two hours: then boil it with twice its weight of water during a quarter of an hour, and after the requisite subsidence pour off the clear liquor. Let this be done three times. Filter the mixed washings, and let them evaporate in a silver vessel. Let the residual salt, whilst becoming dry, be reduced by frequent stirrings to a granular form; then let it be heated to an obscure red. Before it has perfectly cooled take it from the vessel, and preserve it in well-stoppered bottles.

When bicarbonate of potash is submitted to a low red heat it loses half its carbonic acid, and is converted into the carbonate.

When bitartrate is ignited various volatile substances are evolved, and the residue in the crucible is a mixture of charcoal and carbonate of potash, and is denominated *black flux*. "If made with raw tartar, which contains nitrogen, it is contaminated with bicyanide of potassium" (Turner). By roasting, the charcoal is burnt off, and nearly pure carbonate of potash is obtained from the residue by lixiviation.

The high price of pearlash has occasionally led to the manufacture of carbonate of potash from *Sal Enixum* (bisulphate of potash), by heating it in a reverberatory furnace with charcoal. This yields a sulphuret of potassium, in consequence of the carbon deoxidizing the bisulphate. By roasting, this sulphuret is decomposed, and converted into carbonate of potash; the sulphur being dissipated, and the potassium combining with oxygen and carbonic acid.

PROPERTIES.—Carbonate of potash is usually kept in a granular condition, on account of the difficulty of crystallizing it. In this state it is commonly denominated *Subcarbonate of Potash* (*Potassæ Subcarbonas*) or *Salt of Tartar* (*Sal Tartari; Sal Absinthii; Kali præparatum*). It is white, inodorous, and strongly alkaline to the taste. It reacts powerfully as an alkali on turmeric. It renders the red sulphate of red cabbage blue, and restores the blue colour of reddened litmus. It is fusible at a red heat; has a strong affinity for water, so that by exposure to the air it attracts water, and becomes liquid, forming the *Oleum Tartari per deliquium*. It is insoluble in alcohol, but is very soluble in water.

Pure carbonate of potash may, though with some difficulty, be crystallized from its aqueous solution. The crystals are rhombic octohedrons, and belong to the right prismatic system.

Characteristics.—It is known to be a carbonate by its effervescing with the strong acids, and by a solution of it causing a white precipitate (soluble in acetic acid) with lime water or with chloride of barium (see the tests for the *carbonates*, p. 334). That it is a potash salt is determined by the tests for potash already mentioned (see p. 481). From the bicarbonate of potash it is distinguished by a solution of bichloride of mercury causing a brick-red precipitate. The presence of chloride of sodium checks or prevents the formation of this precipitate. Sulphate of magnesia produces a white precipitate with the carbonate of potash, and not with the bicarbonate. This test, however, will not recognise the carbonate when mixed with a large quantity of bicarbonate.

COMPOSITION.—Mr. Phillips[p] says, 100 parts of the carbonate of potash of the shops loses about 16 parts of water when heated to redness. Hence, supposing the carbonate to have been pure (which that of commerce never is), its composition would be as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*
Potash	1	48	57·6
Carbonic Acid	1	22	26·4
Water	1½	13·5	16·0
Pure Granulated Carb. Potash	1	83·5	100·0

	Atoms.	*Eq. Wt.*
Carbonate Potash	1	70
Water	2	18
Crystallized Carbonate Potash	1	88

IMPURITIES.—The ordinary impurities in this salt are water, silicic acid, the chlorides, and sulphates. The first is detected by the loss of weight which the salt suffers by heat; the second is recognised by supersaturating with hydrochloric acid, evaporating, and igniting the residue: the silicic acid is insoluble in water. The other impurities are detected by supersaturating the salt with nitric acid: if the resulting solution give a white precipitate with nitrate of silver, the presence of a chloride is to be inferred; if it produce a white precipitate with chloride of barium a sulphate is present.

The *London College* states the following to be the characters of good carbonate of potash:—

> Almost entirely dissolved by water; in an open vessel it spontaneously liquefies. It changes the colour of turmeric brown. When supersaturated with nitric acid, neither carbonate of soda nor chloride of barium throws down any thing, and nitrate of silver but little. 100 parts lose 16 of water by a strong heat; and the same quantity loses 26·3 parts of carbonic acid on the addition of dilute sulphuric acid.

The *Edinburgh College* states, that—

> "100 grains [*of commercial carbonate of potash*] lose not more than 20 on exposure to a red heat: and, when dissolved and supersaturated by pure nitric acid, the solution gives a faint haze with solution of nitrate of baryta, and is entirely precipitated by 100 minims of solution of nitrate of silver [*Ph. Ed.*]"
>
> *Pure Carbonate of Potash* "does not lose weight at a low red heat: and a solution supersaturated with pure nitric acid is precipitated either faintly, or not at all, by solution of nitrate of baryta or nitrate of silver."

PHYSIOLOGICAL EFFECTS.—Its effects are in *quality* precisely those of caustic potash already described, but their *intensity* is much less, on account of the presence of carbonic acid, which diminishes the alkaline properties of the base. When it is taken into the stomach in large quantities, it acts as a powerfully caustic poison, sometimes inducing death in twelve hours, and producing symptoms similar to those caused by the mineral acids: at other times, however, the patient recovers from the immediate effect of the alkali, but, in consequence of the altered condition of the alimentary canal, the assimilative process cannot be carried on; and, after dragging on a miserable existence for a few weeks, the unfortunate sufferer dies of absolute starvation. And, lastly, in some cases, the caustic operation of the poison is principally confined to the œsophagus, causing stricture and death. In one case, related by Sir Charles Bell[q], a patient swallowed soap lees: this produced inflammation, which terminated in stricture. She lingered for twenty years, and died literally starved. Several other cases have been detailed[r]. In one case no vomiting occurred, but death took place from suffocation[s]. A weak solution of carbonate of potash produces no change in the sanguineous particles drawn from the body: a saturated solution slightly and gradually diminishes their size.

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[p] *Translation of the Pharmacopœia*, p. 284. 4th ed. 1841.

Uses.—This salt is employed, in medicine, in most of the cases already mentioned when describing the uses of caustic potash. For example, as an antacid in dyspeptic affections; as a diuretic; as an antacid in that form of lithiasis which is accompanied with an increased secretion of lithic acid, or the lithates; in those forms of inflammation in which there is a tendency to the formation of false membranes; in gout, &c. On the recommendation of Mascagni[t], it has been employed in peripneumonia and other inflammatory diseases with benefit[u]. Mixed with cochineal it is a popular remedy for hooping-cough. Externally, it has been applied in the form of a solution to wounds; as an injection in gonorrhœa; as a collyrium in some affections of the cornea, &c. Lastly, it is sometimes employed in the manufacture of the common effervescing draught, made with either the citric or tartaric acid.

20 grs. of Carbonate of Potash are saturated by about	17 grs. of commercial crystals of Citric Acid, 18 grs. of crystals of Tartaric Acid, fʒiv. of Lemon Juice.

Administration.—It may be given either in the solid or liquid state. In the solid state it is given in doses of from gr. x. to ʒss.

Antidotes.—When swallowed as a poison, the antidotes are oils or acids, as already mentioned for caustic potash.

LIQUOR POTASSÆ CARBONATIS, L.; *Potassæ Carbonatis Aqua*, D.; *Aqua Kali; Solution of Carbonate of Potash.* (Carbonate of Potash,

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[q] *Surgical Observations*, part i. p. 82.
[r] Christison, *On Poisons*.
[s] *Lancet*, 1834-5, vol. ii. p. 660.
[t] *Memoria della Società Italiana delle Scienze*, t. xi. Modena, 1804.—Negri, *Lond. Med. Gaz.* vol. xiv. p. 713.
[u] See pp. 194, 483, and 485.

℥xx.; Distilled Water, Oj., dissolve and strain, *L.*—Carbonate of Potash from crystals of Tartar, *one part;* Distilled Water, *two parts.* Dissolve and filter. The sp. gr. of this solution is 1·320). A colourless, inodorous solution. Prepared according to the London Pharmacopœia, its sp. gr. is 1·473.—Dose, ♏x. to f℥j.

10. POTAS'SÆ BICAR'BONAS, *L. E. D.*—BICARBONATE OF POTASH.

History.—This salt, formerly called *carbonate of potash* or *aërated kali*, was first prepared by Cartheuser, in 1752.

The *London College* orders it to be prepared with Carbonate of Potash, lbvj.; Distilled Water, *Cong.* j. Dissolve the Carbonate of Potash in the Water, afterwards pass Carbonic Acid through the solution to saturation. Apply a gentle heat, so that whatever crystals have been formed may be re-dissolved. Then set aside (the solution), that the crystals may be again produced: the liquor being poured off, dry them.

Carbonic Acid is very easily obtained from chalk, rubbed to powder, and mixed with water, to the consistence of a syrup, upon which Sulphuric Acid is then poured, diluted with an equal weight of Water.

The process of the *Dublin College* is similar, except that when the solution becomes turbid [from the precipitation of silicic acid], it is to be filtered, and again exposed to the stream of carbonic acid gas. The gas is ordered to be generated by the action of diluted muriatic acid on white marble.

In this process each equivalent of carbonate of potash unites with an additional equivalent of carbonic acid, and thereby forms the bicarbonate. The silicic acid is separated partly while the carbonic acid is passing through the solution, and partly during the crystallization of the bicarbonate.

At Apothecaries' Hall, London, the process is conducted in two iron vessels; in one of which carbonic acid is generated (by the action of sulphuric acid on whiting), in the other is contained the solution of carbonate of potash, through which the carbonic acid is passed. "The following proportions may be used for the preparation of bicarbonate of potassa upon the large scale:—100 lbs. of purified carbonate of potassa are dissolved in 17 gallons of water, which, when saturated with carbonic acid, yield from 35 to 40 lbs. of crystallized bicarbonate; 50 lbs. of carbonate of potassa are then added to the mother-liquor, with a sufficient quantity of water to make up 17 gallons, and the operation repeated (*Hennell*)[v]." Sulphuric is preferable to muriatic acid for generating carbonic acid, as being both cheaper and less volatile.

The *Edinburgh College* directs it to be prepared from Carbonate of Potash, ℥vj.; and Carbonate [Hydrated Sesquicarbonate] of Ammonia, ℥iijss. Triturate the Carbonate of Ammonia to a very fine powder; mix with it the Carbonate of Potash; triturate them thoroughly together, adding by degrees a very little Water, till a smooth and uniform pulp be formed. Dry this gradually at a temperature not exceeding 140°, triturating occasionally towards the close, and continue the desiccation till a fine powder be obtained, entirely free of ammoniacal odour.

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[v] Brande, *Manual of Chemistry*, 5th ed. p. 642. Lond. 1841.

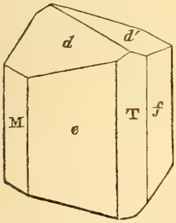
In this process the volatility of the ammonia, and the affinity of the carbonate of potash for more carbonic acid, together cause the decomposition of the sesquicarbonate of ammonia: the ammonia with a small portion of carbonic acid is disengaged, while the remaining acid converts the carbonate into the bicarbonate of potash.

The process adopted by the Edinburgh College is that commonly known as *Cartheuser's process.* MM. Henry and Guibourt[w] give the following directions for its performance:—

Dissolve 500 parts of (pure) carbonate of potash in 1000 parts of distilled water, and filter: place the solution in a porcelain capsule in a salt-water bath, and gradually add 300 parts of pulverized carbonate of ammonia: slightly agitate the liquor until only a feeble disengagement of ammonia is perceived, then filter over a heated vessel, and put aside to cool. The proportions employed by Geiger[x] are somewhat different: they are, a pound of carbonate of potash, sixteen ounces of water, and six ounces of carbonate of ammonia.

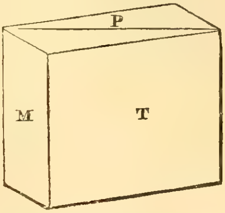
PROPERTIES.—It is a crystalline, colourless solid. The crystals belong to the oblique prismatic system[y]. The primary form is, according to Mr. Brooke[z], a right oblique-angled prism. It is inodorous, has an alkaline taste, and re-acts very feebly as an alkali on vegetable colours. It is soluble in four times its weight of water at 60° F., but is insoluble in alcohol. When exposed to the air it undergoes no change. When exposed to a red heat it gives out half its carbonic acid, and becomes the carbonate.

FIG. 85.



Modified Prism of Carbonate of Potash.

FIG. 86.



Prism derived by Cleavage.

Characteristics.—The presence of carbonic acid and potash in this salt is known by the tests for these substances before mentioned. From the carbonate of potash it is best distinguished by a solution of bichloride of mercury, which causes a slight white precipitate or opalescence with it: whereas with the carbonate it causes a copious brick-red precipitate. This test, however, will not, under all circumstances, detect the carbonate; as when the quantity is very small;

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[w] *Pharmacopée Raisonée*, 3^{me} éd. p. 605. Paris, 1841.

[x] *Handbuch der Pharmacie*, 3^{tte} Aufl.

[y] Rose.

[z] *Annals of Philosophy*, N. S. vol. vi. p. 42.

or when chloride of sodium is present. Sulphate of magnesia will not prove the absence of all carbonate, as I have before stated (p. 518).

Composition.—The composition of this salt is a follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berard.*
Potash	1	48	47·58	48·92
Carbonic Acid	2	44	43·60	42·01
Water	1	9	8·82	9·07
Crystallized Bicarbonate Potash	1	101	100·00	100·00

Impurities.—The presence of chlorides and sulphates may be recognised in this salt as in carbonate of potash (see p. 518). Bichloride of mercury may be employed to detect carbonate of potash, with which it forms a brick-red coloured precipitate.

Totally dissolved by water, the solution changes the colour of turmeric. Sulphate of magnesia throws down nothing from this solution, unless it be heated. From 100 parts, 30·7 are expelled by a red heat. After the addition of excess of nitric acid, chloride of barium throws down nothing, and nitrate of silver very little, if any thing, *Ph. Lond.*

"A solution in 40 parts of water does not give a brick-red precipitate with solution of corrosive sublimate; and when supersaturated with nitric acid, is not affected by solution of nitrate of baryta or nitrate of silver," *Ph. Ed.*

Physiological Effects.—The effects of this salt are similar to those of the carbonate of potash, except that its local action is much less energetic, in consequence of the additional equivalent of carbonic acid. Hence it is an exceedingly eligible preparation in lithiasis and other cases where we want its constitutional, and not its local, action.

Uses.—It may be employed for the same purposes that we use caustic potash (vide *Potash*), except that of acting as an escharotic. Thus, it is used as an antacid, to modify the quality of urine, in plastic inflammation, in glandular diseases, affections of the urinary organs, &c. But its most frequent use is that for making effervescing draughts, with either citric or tartaric acid. The proportions are as follows:—

20 grs. of Crystallized Bicarbonate of Potash are saturated by about
- 14 grs. of Commer^{l} Crystals of Citric Acid,
- 15 grs. of Crystallized Tartaric Acid,
- ʒiijss. of Lemon Juice.

Where there is great irritability of stomach, I believe the effervescing draught, made with bicarbonate of potash and citric acid, to be more efficacious than that made with carbonate of soda and tartaric acid; the resulting *Citrate of Potash* (*Potassæ Citras*) being, in my opinion, a milder preparation than the tartrate of soda. The citrate promotes slightly the secretions of the alimentary canal, the cutaneous transpiration, and the renal secretion; and, like other vegetable salts of potash, renders the urine alkaline.

Administration.—This salt may be given in doses of from gr. x. to gr. xv., or to the extent of half a drachm, or even a drachm.

1. LIQUOR POTASSÆ EFFERVESCENS, L.—*Potassæ Aqua Effervescens*, E.; *Effervescing Solution of Potash.* (Bicarbonate of Potash, ʒj.; Distilled Water, Oj. Dissolve the Bicarbonate of Potash in the

Water, and pass into it of Carbonic Acid, compressed by force, more than sufficient for saturation. Keep the solution in a well-stoppered vessel). This is a solution of bicarbonate of potash, surcharged with carbonic acid. It is an agreeable mode of exhibiting bicarbonate of potash, without injuring its medicinal power. It may be extemporaneously imitated by pouring a bottle of soda-water (i. e. *carbonic acid water*) into a tumbler containing grs. xx. of bicarbonate of potash.

2. **LEMON AND KALI.**—Under this name is kept in the shops a mixture of powdered white sugar, dried and powdered citric acid, and powdered bicarbonate of potash. It is employed as an extemporaneous effervescing draught. As it abstracts water from the atmosphere, it must be preserved in a well-stoppered bottle (See *Pulveres Effervescentes*, Ph. Ed.)

11. POTAS'SÆ ACE'TAS, *L. E. D.*—ACETATE OF POTASH.

History.—It appears to have been first clearly described by Raymond Lully, in the thirteenth century, and has been known by several appellations; such as *Terra Foliata Tartari*, *Diuretic Salt*, &c.

Natural History.—Geiger[a] says this salt is found in some mineral springs. It probably exists in most of those plants which, by incineration, yield carbonate of potash. The sap of the elm, and of most trees, Winter's bark, linseed, senna leaves, the rhizome of ginger, &c. are said to contain it.

Preparation.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Carbonate of Potash, lbj.; Acetic Acid, f℥xxvj.; Distilled Water, f℥xij. Add the carbonate of potash to the acid, first mixed with water, to saturation, then strain. Evaporate the liquor in a sand-bath, the heat being cautiously applied, until the salt is dried.

The *Edinburgh College* orders of Pyroligneous Acid, Oiss.; Carbonate of Potash (dry), ℥vij., or a sufficiency. Add the carbonate gradually to the acid till complete neutralization is accomplished. Evaporate the solution over the vapour-bath till it is so concentrated as to form a concrete mass when cold. Allow it to cool and crystallize in a solid cake; which must be broken up, and immediately put into well-closed bottles.

The *Dublin College* gives the following directions for its preparation:—Take of Carbonate of Potash from Crystals of Tartar any required quantity. Pour on it, by repeated additions, Distilled Vinegar of a *medium* heat, and in quantity about five times the weight of the salt. When the effervescence shall have ceased, and the liquor have given off vapours during some time, let the additions of distilled vinegar be repeated at intervals, until effervescence shall have completely ceased. By continued evaporation the salt will become dry, and by a moderate increase of the heat it is to be cautiously liquefied. When the salt has cooled, let it be dissolved in water: filter the liquor, and boil it down until, when removed from the fire, on cooling, it forms a mass of crystals.

In this process the acid unites with the potash of the carbonate, and disengages carbonic acid.

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[a] *Handbuch der Pharmacie.*

PROPERTIES.—It is usually met with as a colourless, white solid, with a foliated texture (which is given to it by fusion and cooling), odourless, but having a pungent saline taste, and a soapy feel. It is exceedingly deliquescent; and, therefore, ought to be preserved in a well-stoppered bottle. It is very soluble both in water and alcohol; indeed, in water, it is one of the most soluble salts we are acquainted with. At 60°, 100 parts of the salt will dissolve in 102 parts of water. When heated, it fuses, and is decomposed into *acetone* or *pyroacetic spirit* ($C^3 H^3 O$) and *carbonate of potash.* One equivalent of this spirit contains the elements of one equivalent of acetic acid, minus those of one equivalent of carbonic acid.

Characteristics.—See the tests for the *acetates*, p. 397, and for *potash*, p. 481. Its deliquescence is a characteristic.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wenzel.*
Potash	1	48	48·5	50·15
Acetic Acid (dry)	1	51	51·5	49·85
Acetate of Potash	1	99	100·0	100·00

IMPURITY.—It should be white and perfectly neutral. Frequently, however, it re-acts as an alkali, owing to a slight excess of potash. The presence of chlorides may be detected by nitrate of silver; of sulphates, by chloride of barium; of metals, by hydrosulphuric acid, or ferrocyanide of potassium.

PHYSIOLOGICAL EFFECTS.—Two or three drachms cause purging, which is sometimes accompanied with griping. In smaller cases, more especially if largely diluted, this salt acts as a mild diaphoretic. In its passage to the kidneys it becomes decomposed, and is converted into the carbonate of potash, which may be detected in the urine. Probably the pulmonary excretions of those who employ it also become impregnated with this salt, since it has been said that in persons with delicate lungs it acts as an irritant to these organs.

USES.—In this country it is rarely employed, except as a diuretic in dropsical complaints. It is a valuable adjunct to other renal excitants. On the continent, it is administered in various diseases, as an alterative or resolvent. Thus in scirrhus of the pylorus, chlorosis, and visceral and glandular enlargements. It may be employed, in the lithic acid diathesis, to render the urine alkaline. It is of course improper when phosphatic deposits are observed in the urine.

ADMINISTRATION.—It is given as a diuretic in doses of from a scruple to a drachm and a half, dissolved in some mild diluent. In larger doses, as two or three drachms, it acts as a purgative.

12. POTAS'SÆ BITAR'TRAS, *L. E. D.*—BITARTRATE OF POTASH.

HISTORY.—In its impure form, as a deposit from wine, it must have been known at a very early period. "It is called *tartar*," says Paracelsus, "because it produces oil, water, tincture, and salt, which burn the patient as *hell* does." Scheele, in 1769, first explained its nature. Its synonymes are *Cream of Tartar*, *Supertartrate of Potash*, and *Acidulous Tartrate of Potash.*

Natural History.—It is a constituent of many vegetables: thus it is found in Grapes, Tamarinds, *Cetraria islandica*, &c.

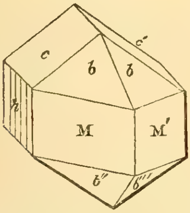
Production.—All the bitartrate of commerce is obtained during the vinous fermentation. It exists in solution in grape juice; but being very slightly soluble in a mixture of alcohol and water, it deposits during fermentation (that is, when alcohol is produced), and forms a crust on the sides of the cask. In this state it is known in commerce under the name of *Crude Tartar* (*Tartarus crudus*), or *Argol*, and which is termed *White* or *Red* (*Tartarus albus* vel *Tartarus ruber*), according as it is obtained from white or red wine.

Argol, or *Crude Tartar*, occurs in crystalline cakes of a reddish colour, and is composed of the bitartrate of potash, tartrate of lime (and sometimes biracemate of potash), colouring and extractive matter, &c.

At Montpellier, bitartrate of potash is procured thus:—Argol is boiled in water, and the solution allowed to cool, by which a deposit of crystals is obtained; these are washed with cold water, and dissolved in boiling water, containing charcoal and alumina (clay); the latter substances being employed to remove the colouring matter with which they precipitate. The clear liquor is allowed to cool slowly, by which crystals of the bitartrate are formed. These constitute the *Tartarus depuratus* or *Crystalli Tartari* of the older chemists. If a hot saturated solution of tartar be cooled, the surface of the liquid becomes coated by a layer of very fine crystals of bitartrate: hence this crust was called *Cream of Tartar* (*Cremor Tartari*).

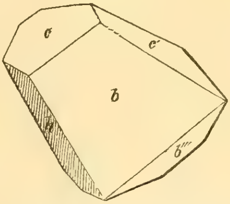
Properties.—As met with in commerce, this salt forms a white crystalline mass, without odour, but having an acidulous and gritty taste. According to Mr Brooke[b] its crystals are right rhombic prisms (figs. 87 and 88). Liebig[c], however, says they are oblique rhombic prisms. It is unaltered by exposure to the air; but when heated, it decomposes, swells up, evolves various volatile products, gives out an odour of caramel, and is converted into *Black Flux (Fluor niger)*,—a compound of charcoal and carbonate of potash (see p. 517). If the

Fig. 87.



An ordinary perfect Crystal of Bitartrate of Potash.

Fig. 88.



Common Crystal of ditto.

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[b] *Ann. of Phil.* N. S. vol. vii. p. 161.

[c] Turner's *Chemistry*, 7th ed.

bitartrate be deflagrated with nitrate of potash, the residue is *White Flux* (*Fluor albus*), or carbonate of potash (see p. 517). Bitartrate of potash is very slightly soluble in water, and is insoluble in alcohol.

Characteristics.—One character of this salt is derived from the phenomena attending its conversion into black flux, as above mentioned. If black flux be digested in water we obtain a solution of carbonate of potash, known by the properties before mentioned (p. 517). Another character of the bitartrate is its slight solubility in water, and its solution reddening litmus. The addition of caustic potash increases its solubility, whereas alcohol diminishes it. Acetate of lead added to a solution of the bitartrate forms a copious white precipitate; lime water has the same effect. Mixed with alkaline carbonates it produces effervescence. Boracic acid, or borax, very much increases the solubility of this salt in water, forming what has been termed *Soluble Cream of Tartar (Cremor Tartari solubilis)*, or *Tartarus Boraxatus* of some writers.

COMPOSITION.—Crystallized bitartrate of potash has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*
Potash	1	48	25·3	24·80
Tartaric Acid	2	132	70·0	70·45
Water	1	9	4·7	4·75
Crystallized Bitartrate of Potash	1	189	100·0	100·00

IMPURITY.—Bitartrate of potash usually contains from 2 to 5 per cent. of tartrate of lime, and hence a little carbonate of lime may be detected in black flux. This is of no material consequence in a medicinal point of view. If the powdered bitartrate be adulterated with either alum or bisulphate of potash, the fraud may be detected by chloride of barium, which causes a white precipitate (*sulphate of baryta)* insoluble in nitric acid.

It is sparingly dissolved by water. It renders the colour of litmus red. At a red heat it is converted into carbonate of potash. *Ph. Lond.*

"Entirely soluble in 40 parts of boiling water: forty grains in solution are neutralized with 30 grains of crystallized carbonate of soda; and when then precipitated by 70 grains of nitrate of lead, the liquid remains precipitable by more of the test." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—When taken in *small doses,* diluted with water, it acts as a refrigerant and diuretic: in *larger doses* (as two or three drachms) it purges, and frequently creates flatulence and griping. By continued use it disorders the digestive functions, and causes emaciation, most probably from defective nutrition. In *excessive doses* it produces inflammation of the stomach and intestines. A fatal case has been recorded by Mr. Tyson[d]. A man, to relieve the effects of drunkenness, swallowed four or five tablespoonfuls of cream of tartar. It caused violent vomiting and purging, and other symptoms of gastro-enteritis, and pain in the loins. The thighs and legs appeared paralyzed. He died on the third day. On a post-mortem examination the stomach and intestines were found inflamed.

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[d] *Lond. Med. Gaz.* vol. xxi. p. 177.

Uses.—Bitartrate of potash is frequently employed to form a refrigerant drink in febrile and inflammatory diseases. It allays thirst, diminishes preternatural heat, and reduces vascular action. As a *diuretic* in dropsical complaints it is used either in the same way, or taken in the form of an electuary. As a *purgative* it is not usually exhibited alone, but, in general, with jalap, sulphur, senna, or some other purgative. Thus, in dropsical complaints, a very valuable hydragogue cathartic is a mixture of jalap and bitartrate of potash. In skin diseases and affections of the rectum (as piles, stricture, and prolapsus), a very useful purgative is an electuary composed of sulphur, bitartrate of potash, and confection of senna. An effervescing aperient may be prepared by mixing three drachms of the bitartrate with two and a half drachms of carbonate of soda: the resulting salt is the potash-tartrate of soda. As a *tooth-powder*, bitartrate of potash is sometimes used on account of its gritty qualities: a very good dentifrice consists of equal parts of bitartrate, powdered rhatany root, and myrrh (see some observations on dentifrices at p. 219).

Administration.—As a hydragogue cathartic the dose is from four to eight drachms: as an aperient, one or two drachms: as a diuretic, in repeated doses of a scruple to a drachm (See *Pulvis Jalapæ Compositus*).

1. **IMPERIAL**; *Tisana Imperialis.*—It is formed by dissolving one drachm or a drachm and a half of cream of tartar in a pint of boiling water, and flavouring with lemon-peel and sugar. When cold the solution may be taken, *ad libitum*, as a refrigerant drink in febrile complaints, and as a diuretic.

2. **SERUM LACTIS TARTARIZATUM**; *Cream of Tartar Whey.*—This is prepared by adding about two drachms of the bitartrate to a pint of milk. It may be diluted with water, and taken in febrile and dropsical complaints.

13. POTAS'SÆ TAR'TRAS, *L. E. D.*—TARTRATE OF POTASH.

History.—This salt was known to Lemery. It has been termed *Tartarized Tartar*, *Tartarized Kali*, *Soluble Tartar*, or *Vegetable Salt*.

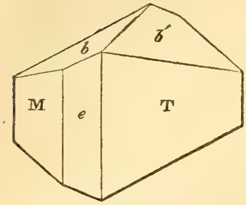
Preparation.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Bitartrate of Potash, powdered, lbiij.; Carbonate of Potash, ℥xvj., or as much as may be sufficient; Boiling Water, Ovj. Dissolve the carbonate of potash in the boiling water, then add the bitartrate of potash, and boil. Strain the liquor, and afterwards boil it down until a pellicle floats, and set it aside that crystals may be formed. The liquor being poured off, dry these, and again evaporate the liquor that crystals may be produced.

The processes of the *Edinburgh* and *Dublin Colleges* are essentially the same.

In this process the excess of acid in the bitartrate is saturated by the potash of the carbonate: the carbonic acid escapes.

Fig. 89.



Crystal of Tartrate of Potash.

Properties.—It is usually met with in the shops in a granular state, but it ought to be crystallized. Its crystals are right rhombic prisms. To the taste this salt is saline, and somewhat bitter. It deliquesces when exposed to the air, and is soluble in its own weight of water at 50°; the solution decomposes by keeping.

Characteristics.—When heated to redness it is decomposed, leaving as a residue charcoal and carbonate of potash. A solution of the tartrate produces white precipitates with solutions of acetates of lead, nitrate of silver, and chloride of calcium; the precipitates being soluble in nitric acid. Bichloride of platinum, assisted by heat, causes a black precipitate in a solution of this salt. When heated, the salt evolves the odour of caramel. If an excess of any strong acid (as the sulphuric) be added to a solution of this salt, we obtain crystals of the bitartrate. Hence acids, and most acidulous salts, are incompatible with it: as also are tamarinds. The tartrate is readily distinguished from the bitartrate by its deliquescent property, its greater solubility, and its want of acidity.

Composition.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*
Potash	1	48	42·1	41·31
Tartaric Acid	1	66	57·9	58·69
Tartrate of Potash	1	114	100·0	100·00

The large crystals contain, according to Dr. Thomson[e], two equivalents of water. The same authority states, that he has had crystals of this salt in needles which seemed to contain no water of crystallization.

Impurity.—It may contain excess of acid or of base, either of which is easily recognised; the one by litmus, the other by turmeric. The sulphates may be detected by chloride of barium throwing down a white precipitate insoluble in nitric acid.

Physiological Effects.—This salt is a gentle purgative, analogous in its action to the sulphate of potash, from which it differs in being milder in its operation, and partially digestible; for, like the other vegetable salts of the alkalis, it is decomposed in the system, and converted into the carbonate, in which state it is found in the urine.

It is said to have the power of preventing the griping of other more active cathartics, as senna and scammony; but, from my own personal observations, I doubt the correctness of this statement.

Uses.—It is employed as a mild purgative in dyspepsia, at the commencement of diarrhœa, in some liver complaints, &c. Sometimes it is used as an adjunct to other more active purgatives; as the infusion of senna.

Administration.—It may be given in doses of from two or three drachms to half an ounce, or even an ounce.

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[e] *First Principles of Chemistry,* v ii. p. 264.

ORDER XII.—COMPOUNDS OF SODIUM.

1. SO'DII CHLO'RIDUM, *L.*—CHLORIDE OF SODIUM.

(Sodæ Murias, *E. D.*)

HISTORY.—As this salt is a necessary and indispensable seasoning to our food, it doubtless must have been known to, and employed by, the first individuals of our race. The earliest notice of it occurs in the writings of Moses[f], and Homer[g]. It has received various names, such as *Common Salt, Culinary Salt,* and *Muriate* or *Hydrochlorate of Soda.*

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—An enormous quantity of this salt is contained in the waters of the ocean. At an average calculation sea water contains 2·5 per cent. of chloride of sodium[h]. It is found also in great abundance in mineral waters[i]. It has not hitherto been found in the oldest stratified rocks[j], but is met with in all the later formations. Thus Mr. Featherstonhaugh[k] states, that salt or brine springs occur in certain parts of the United States[l], in the *old transition slate rocks.* Salt springs occur in various parts of England, in the *coal measures*[m]. The rock salt of Cheshire, and the brine springs of Worcestershire, occur in the *old red sandstone group*[n]. The salt of Ischel, in the Austrian Alps, belongs to the *oolitic group*[o], as does also that found in the lias in Switzerland[p]. The immense mass or bed of salt near Cardona, in Spain, and which has been described by Dr. Traill[q], occurs in the *cretaceous group*[r]. The salt deposit of Wieliczka, near Cracow, belongs to the *supracretaceous group*[s]. Lastly, in the Crimea, salt is said to be daily accumulating in the inland lakes.

β. IN THE ORGANISED KINGDOM.—It is found in plants which grow by the sea side, in the blood and urine of man, &c.

PREPARATION.—The salt consumed in this country is procured by the evaporation of the water of brine springs. The salt districts are, Northwich, Middlewich, and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. In Cheshire the rock salt (called also *Fossil Salt, Sal Fossilis* or *Sal Gemmæ*) constitutes two beds, which vary in thickness from 4 to 130 feet, and are separated by a bed of clay, 10 or 12 feet thick; the uppermost bed of salt being 30 or more feet from the surface of the earth. It is for the most part of a reddish colour, but is also met with in transparent colourless masses. It is called in commerce *Prussia rock*, and is largely exported for purification. Brine springs are met with both above and below the level of the beds of rock salt.

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[f] *Gen.* xix. 26; *Lev.* ii. 13.

[g] *Iliad,* lib. ix. 214.

[h] Vide p. 263.

[i] Gairdner, *On Mineral Springs,* p. 12.

[j] De la Beche, *Researches in Theoret. Geol.* p. 31.

[k] *Phil. Mag.* N. S. vol. v. p. 139; vol. vi. p. 75; and vol. vii. p. 198.

[l] For an account of the American salt formation, consult J. Van Rensselaer's *Essay on Salt, containing Notices of its Origin, Formation, Geological Position, and principal Localities, embracing a particular Description of the American Salines.* New York, 1823.—This author states that the American salt formation occurs in the old red sandstone.

[m] Bakewell, *Introd. to Geology,* 4th ed. p. 252.

[n] *Trans. Geol. Society,* vol. i. p. 38, and vol. ii. p. 94.

[o] Sedgwick and Murchison, *Phil. Mag.* N.S. vol. viii. p. 102.

[p] Bakewell, *op. cit.* p. 253.

[q] *Trans. Geolog. Society,* vol. iii. p. 404.

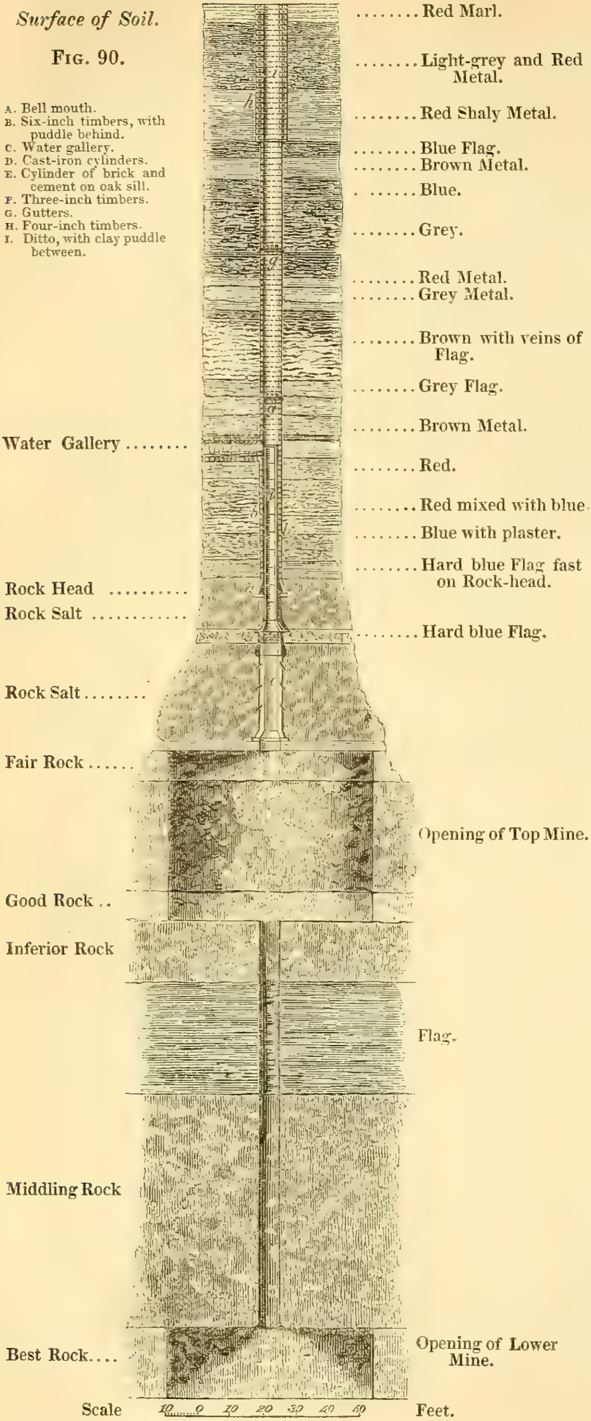
[r] De la Beche, *op. cit.* p. 293.

[s] Ibid. p. 270.

The brine is pumped up into cisterns or reservoirs, from which it is drawn when wanted into large oblong wrought-iron evaporating pans, which are usually worked with four or more fires. If the brine be not completely saturated with chloride of sodium, a little rock salt is added to it. By the evaporation of the water the salt deposits in crystals. The impurities separate in the form of a scum (which is removed by a skimming-dish), and of a sediment called *pan-scale, pan-scratch*, or *pan-bake*. The grains or crystals of salt vary in size, according to the degree of heat employed in their preparation. The small-grained salt is formed by the strongest heat, and

Surface of Soil.

FIG. 90.

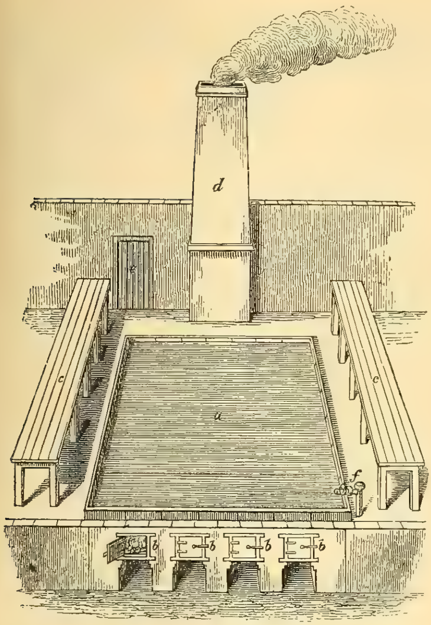


A. Bell mouth.
B. Six-inch timbers, with puddle behind.
C. Water gallery.
D. Cast-iron cylinders.
E. Cylinder of brick and cement on oak sill.
F. Three-inch timbers.
G. Gutters.
H. Four-inch timbers.
I. Ditto, with clay puddle between.

Section of the Wharton Salt Mine, on the River Weaver, Cheshire.

constitutes the *butter*, *stoved*, *lump*, or *basket salt* of commerce; while the larger crystals, forming the *bay* and *fishery salts* of commerce, are formed at a lower temperature[t].

Fig. 91.



Common Salt Pan.

a. A flat shallow pan, varying in width and length from 20 feet and upward, and 15 inches deep, made of thick wrought iron.
b. Fire-places, the flues of which go direct to the chimney.
c. Hurdles on which the salt is drawn, to allow it to drain before it is conveyed to the store.
d. Chimney at extremity of pan.
e. Door of the store.
f. Feed-cock supplying brine to the pan.

In some parts of the world chloride of sodium is obtained from sea water: but the mode of extracting it varies according to circumstances. In France and on the shores of the Mediterranean, it is procured by solar evaporation, and is then called *Bay Salt.*

The French *salt marshes* are shallow basins or pans of clay, excavated along the sea shore. The water is admitted, by a sluice, into a reservoir, where evaporation goes on while mechanical impurities are deposited. It then passes by a subterraneous communication into a series of rectangular pans, and proceeds by a very circuitous route through them to another subterranean gutter, by which it is conveyed into a long, narrow, circuitous canal. From this it passes into a second, and subsequently into a third series of salt pans. During the whole of this time it is undergoing evaporation, and when it arrives at the third series of pans it is so far concentrated that crystallization is soon effected. The salt is known to be on the point of crystallizing when the liquid assumes a reddish tint. It is then withdrawn from the pans, and collected upon the borders, in conical or pyramidal heaps, when it drains and dries. These operations begin in March and finish in September[u].

At Lymington[v], in Hampshire, salt is prepared from the sea water, which is admitted into a reservoir or pond, and from this successively into three series of brine-pits or salt-pans, where the water is partly evaporated by solar heat. When the liquid has acquired a sufficient density, it is conveyed into rectangular iron pans, where it is evaporated. Eight hours are required to boil each charge to dryness. The salt is then removed into wooden troughs or cisterns, perforated by holes in the bottom, where it is allowed to drain, and is afterwards removed to the warehouse, where it also drains. The drainings from the wooden trough drop on upright stakes (old broom handles, &c.), and on these the salt concretes, in the course of ten or twelve days, forming large stalactitic masses called *salt-cats*, each weighing 60 or 80 lbs. The residual liquor (*bittern* or *the bitter liquor*) is received into underground pits, and during the winter season is used in the manufacture of Epsom salt (see *Sulphate of Magnesia*).

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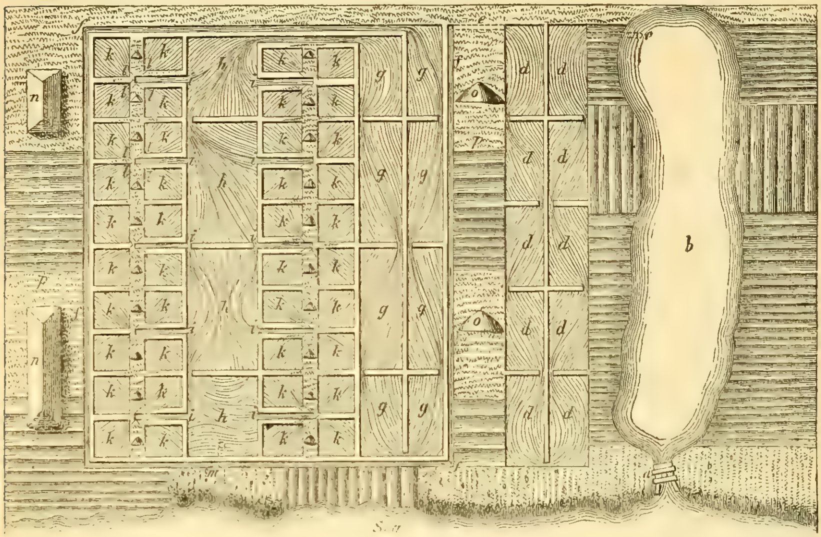
[t] For further information on the manufacture of common salt, consult Aikin's *Dictionary of Chemistry*, vol. ii. p. 118; Holland's *Agricultural Survey of Cheshire*; Dr. Henry, *Phil. Trans.* 1810; Mr. Furnival's *Wharton and Marston Patent Salt Refineries*, 1836; Dr. Brownrigg's *Art of making Common Salt*, 1748; and Dr. Jackson, *Phil. Trans.* No. 53, p. 1060.

[u] For further details, see *Phil. Trans.* No. 51, p. 1025; and Dumas, *Traité de Chimie*, t. ii.

[v] Dr. Henry (*Phil. Trans.* 1810) has described the method of manufacture. In the summer of 1840, I visited the Salterns at Lymington, and can confirm the accuracy of Dr. Henry's statements. I found *Salicornia herbacea* growing abundantly in the salt-pans. The sp. gr. of the liquor in the pans is ascertained by glass bulbs (on the principle of Lovi's beads) placed in a wicker basket, which is immersed in the water by a long handle.

FIG. 92.



Salt Marshes.

a. Sluice by which the sea water is admitted.
b. Reservoir.
c. Subterranean channel by which the water passes from *b* into *d*.
d, d. First series of brine-pits or salt-pans.
e. Subterranean channel by which the water passes from *d* to *f*.
f. A long, narrow, circuitous canal.
g, g. Second series of pans.
h, h. Third ditto.
i, i. Canal.
k, k. Last series of pans.
l, l. Subterranean channel by which the water passes from *i* to *k*.
m. Subterranean channel by which the rinsings of the pans escape into the sea.
n, n. Pyramidal heaps of bay salt.
o, o. Conical heaps of ditto.
p, p. Ground of the proprietor of the marshes.

In cold countries, congelation is resorted to as a means of concentrating sea water; for when a weak saline solution is exposed to great cold, it separates into two parts: one almost pure water, which freezes, and the other which remains liquid, and contains the larger proportion of salt. Another method of concentration is by *graduating houses:* these are skeletons of houses, in which the water is pumped up, and allowed to fall on heaps of brushwood, thorns, &c., by which it is divided and agitated with the air, and evaporation promoted. The further concentration is effected by heat.

PURIFICATION.—The *Edinburgh College* gives the following directions for the preparation of *Pure Chloride of Sodium* (*Sodæ Murias purum*, E.)

> "Take any convenient quantity of Muriate of Soda; dissolve it in boiling water; filter the solution, and boil it down over the fire, skimming off the crystals which form; wash the crystals quickly with cold water and dry them."
>
> A solution of this pure salt "is not precipitated by solution of carbonate of ammonia followed by solution of phosphate of soda: a solution of 9 grains in distilled water, is not entirely precipitated by a solution of 26 grains of nitrate of silver."

The carbonate of ammonia and phosphate of soda are employed to detect the presence of any magnesian salt.

PROPERTIES.—It crystallizes in colourless cubes, or more rarely in regular octohedrons. In the salt pans the little cubes are frequently so aggregated as to form hollow, four-sided pyramids, whose sides have some resemblance to a series of steps: these are technically called *hoppers*. The specific weight of salt is 2·17. The taste is pure saline. When free from all foreign matters, chloride of sodium is permanent in the air, but ordinary salt is slightly deliquescent, owing to the presence of small quantities of chloride of magnesium. When heated it decrepitates (more especially the coarse-grained or bay salt), at a red heat fuses, and at a still higher temperature volatilizes. Rock salt is transcalent or diathermanous: that is, it transmits radiant heat much more readily than many other transparent bodies, as glass (see p. 7). It is soluble in water, and slightly so in alcohol. Hot and even boiling water dissolves very little more salt than cold water. At 60° it requires about twice and a half its weight of water to dissolve it.

Characteristics.—Its characters as a soda salt are the following:— Its solution produces no precipitate with the hydrosulphurets, ferrocyanides, phosphates, or carbonates. From the salts of potash it is distinguished by causing no precipitate with perchloric or tartaric acid, or with bichloride of platinum, and by the yellow tinge which it communicates to the flame of alcohol. As a chloride it is known by nitrate of silver throwing down a white precipitate (*chloride of silver*), soluble in ammonia, but insoluble in nitric acid. Lastly, chloride of sodium is odourless, and devoid of bleaching properties.

COMPOSITION.—Pure chloride of sodium has the following composition:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Ure.*
Sodium	1	24	40	39·98
Chlorine	1	36	60	60·02
Chloride of Sodium	1	60	100	100·00

The crystals contain no water in chemical combination with them, but a little is frequently mechanically lodged between their plates.

IMPURITIES.—The commercial salt of this country is sufficiently pure for all dietetical and therapeutical purposes; and its low price is a sufficient guarantee against adulteration. In France, however, serious accidents have happened in consequence of the use of sophisticated salt[w].

COMPOSITION OF VARIOUS KINDS OF SALT (HENRY).

1000 *Parts by Weight consist of*

	Kind of Salt.	Pure Muriate of Soda.	Muriate of Lime.	Muriate of Magnesia.	Total Earthy Muriates.	Sulphate of Lime.	Sulphate of Magnesia.	Total Sulphates.	Insoluble Matter.	Total Impurity.
For. Bay Salt.	St. Ube's	960	trace	3	3	23½	4½	28	9	40
	St. Martin's	959½	do.	3½	3½	19	6	25	12	40½
	Oleron	964¼	do.	2	2	19½	4½	23¾	10	35¾
Brit. Salt fr. Sea-water.	Scotch (common)	935½	—	28	28	15	17½	32½	4	64½
	Scotch (Sunday)	971	—	11½	11½	12	4½	16½	1	29
	Lymington (common)	937	—	11	11	15	35	50	2	63
	Ditto (cat)	988	—	5	5	1	5	6	1	12
Cheshire Salt.	Crushed rock	983¼	0·$\frac{1}{16}$	0·$\frac{3}{16}$	0·¼	6½	—	6½	10	16⅔
	Fishery	986	0·¼	0·¾	1	11¼	—	11¼	1	13¼
	Common	983½	0·¼	0·¾	1	14½	—	14½	1	16½
	Stoved	982½	0·¼	0·¾	1	15½	—	15½	1	17½

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—In minute quantity chloride of sodium is injurious to very few, if any, plants, and to some it appears to be beneficial. Used moderately it is a most excellent manure to certain soils. In large quantities it is injurious, though unequally so, to all plants[x].

β. On Animals.—To marine animals, common salt is a necessary constituent of their drink. It is relished by most land animals. "The eagerness with which many quadrupeds and birds press towards salt springs and lakes, situated in inland districts, for the purpose of tasting their contents, indicates," says Dr. Fleming[y], "a constitutional fondness for salt." In the *Ruminantia* the salutary effects of salt are especially observed. "They contribute powerfully," observes Moiroud[z], "to prevent, in these animals, the influence of rainy seasons and wet pasturage, as well as damaged fodder. Given to animals intended for fattening, it gives more consistence to the fat and more taste to the meat." It appears to be offensive and injurious to many of the lower animals: hence when rubbed on meat, it prevents the attack of insects, and when applied to the skin of leeches causes vomiting.

γ. On Man.—Chloride of sodium serves some important and essential uses in the animal economy. It is employed, on account of its agreeable taste, by the people of all nations, from the most refined to the most barbarous; but the quantity taken varies with different individuals (see the Dietetical Effects of Salt at p. 73). It is an invariable constituent of the healthy blood. Dr. Stevens[a] has shown that in certain states of disease (as cholera) there is a deficiency of the saline matter in the blood, and in those cases the blood has a very dark or black appearance. Some of the properties of the sanguineous fluid, such as its fluidity, its stimulating qualities, and its power of self-preservation, are probably more or less connected with its saline constituents. The chloride of sodium found in some of the secretions, as the bile and tears, doubtless serves some important purposes.

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[w] Christison's *Treatise on Poisons*, 3d ed. p. 604; and Devergie, *Méd. Lég.* t. ii. p. 876.

[x] Davy, *Agricult. Chem.*; and De Candolle, *Phys. Vég.* pp. 1262 and 1343.

[y] *Philosophy of Zoology*, vol. i. p. 316.

[z] *Pharmac. Vétérin.* p. 410.

[a] *On the Blood.*

It is said that persons who take little or no salt with their food are very subject to intestinal worms. Lord Somerville, in his address to the Board of Agriculture, states that the ancient laws of Holland "ordained men to be kept on bread alone *unmixed with salt*, as the severest punishment that could be inflicted upon them in their moist climate; the effect was horrible: these wretched criminals are said to have been *devoured by worms* engendered in their own stomachs." Mr. Marshall[b] tells us of a lady who had a natural aversion to salt: she was most dreadfully affected with worms during the whole of her life.

Considered in a therapeutical point of view, it is an irritant in its local operation. Thus, applied to the skin and the mucous membranes, it causes redness. Taken into the stomach in large quantity (as in the dose of a table-spoonful or more) it excites vomiting; and, when thrown into the large intestines, produces purging. In moderate quantities it promotes the appetite, and assists digestion and assimilation. If used too freely it occasions thirst. The long-continued employment of salted provisions occasions scurvy: of the correctness of this statement there cannot exist, I think, a shadow of doubt, notwithstanding the bold denial given to it by Dr. Stevens[c]; a denial the more remarkable, since Dr. Stevens admits he has never seen a single case of the disease! His opinion is evidently founded on hypothetical grounds, and is in direct opposition to the best medical testimony we possess. In large doses it operates as an irritant poison. A man swallowed a pound of it in a pint of ale, and died within twenty-four hours, with all the symptoms of irritant poisoning. His stomach and intestines were found excessively inflamed[d].

In some diseases the moderate use of salt produces the effects of a tonic. It acts as a stimulant to the mucous membranes, the absorbent vessels, and glands. Occasionally, it seems to merit the designation of liquefacient, alterative, and resolvent (see p. 196). I have already explained (see p. 105) Liebig's notion of the action of the alkaline salts on the tissues.

Properly diluted and injected into the veins, in cholera, it acts as a powerful stimulant and restorative; the pulse, which was before imperceptible, usually becomes almost immediately restored, and, in some cases, re-action and recovery follow. A solution of common salt produces no change in the size and form of the sanguineous particles out of the body[e]. Dr. Macleod injected a solution of common salt into the jugular vein of a rabbit which had been asphyxied, but without restoring or producing resuscitation[f].

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[b] *Med. and Phys. Journal*, vol. xxxix.

[c] *Op. cit.* p. 262.

[d] Christison, *Treatise on Poisons*.

[e] Müller's *Physiology*.

Uses.—The following are some of the most important therapeutical uses of chloride of sodium.

As *a vomit* it has been recommended in malignant cholera, in preference to other emetics[g]. In narcotic poisoning, in the absence of the stomach-pump and the ordinary emetic substances, it may also be employed. The dose of it is one or two table-spoonfuls in a tumblerful of water. A tea-spoonful of flour of mustard assists its action. As a *purgative* it is seldom employed except in the form of enema. One or two table-spoonfuls of common salt dissolved in a pint of gruel form a very useful clyster for promoting evacuations from the bowels.

It has been used, in some diseases, with the view of *restoring the saline qualities of the blood.* In cholera the blood is remarkably black, incapable of coagulating, and contains more albumen and hematosine, but less water and saline parts, than natural; while the enormous discharges from the bowels consist of a weak solution of albumen containing the salts of the blood[h]. The obvious indications, therefore, in the treatment of this disease, are to restore the water and saline matters to the blood. Hence originated what has been called the *saline treatment* of cholera. This, at first, consisted in the exhibition of certain alkaline salts by the mouth, and in the form of enemata. The following are formulæ which have been recommended:—

Take of Carbonate of Soda	half a drachm.
Chloride of Sodium....	a scruple.
Chlorate of Potash	seven grains.

Dissolve in half a tumblerful of water.

This to be repeated at intervals of from 15 minutes to an hour, according to circumstances. (Dr. Stevens, *op. cit.* p. 459.)

Take of Phosphate Soda............	10 grains.
Chloride of Sodium	10 grains.
Carbonate of Soda..........	5 grains.
Sulphate of Soda............	10 grains.

Dissolve in six ounces of water.

The mixture to be repeated every second hour. (Dr. O'Shaughnessy, *op. cit.* p. 54.)

This plan, however, was followed by that of injecting saline solutions into the veins: which was, I believe, first practised by Dr. Latta[i]. The quantity of saline solution which has been in some cases injected is enormous, and almost incredible. In one case "120 ounces were injected at once, and repeated to the amount of 330 ounces in twelve hours. In another, 376 ounces were thrown into the veins between Sunday at 11 o'clock, A. M., and Tuesday at 4, P. M.: that is, in the course of fifty-three hours, upwards of thirty-one pounds. The solution that was used consisted of two drachms of muriate and two scruples of carbonate of soda to sixty ounces of water. It was at the temperature of 108 or 110 deg. F.[k]" In another series of cases 40lbs. were injected in twenty hours: 132 ounces in the first two hours; 8lbs. in half an hour[l]! The *immediate* effects of these injections, in a large majority of cases, were most astonishing: restoration of pulse, improvement in the respiration, voice, and general appearance, return of consciousness, and a feeling of comfort. In many instances, however, these effects were only temporary, and were followed by collapse and death. In some, injurious consequences resulted, as phlebitis[m], drowsiness[n], &c. The reports as to the ultimate benefit of the saline treatment in cholera are so contradictory, that it is exceedingly difficult to offer the student a correct and impartial estimate of its value. That it failed in a large proportion of cases after an extensive trial, and greatly disappointed some of its staunchest supporters, cannot be doubted[o]. Dr. Griffin[p] states, that all the published cases of injection which he can find recorded amount to 282, of which 221 died, while 61 only recovered: but he thinks that the average recoveries from collapse by this method of treatment "far exceeded the amount of any other treatment in the same disease and under the same circumstances."

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[f] *Lond. Med. Gaz.* vol. ix. p. 358.

[g] Searle, *Lond. Med. Gaz.* vol. viii. p. 538; Sir D. Barry, *ibid.* vol. ix. pp. 321 and 407; Brailoff and Isenbeck, *ibid.* p. 490*.

[h] Dr. O'Shaughnessy, *Report on the Chemical Pathology of the Malignant Cholera*, 1832.

[i] *Lond. Med. Gaz.* vol. x. p. 257.

[k] *Ibid.*

[l] *Ibid.* vol. x. pp. 379-80.

Common salt has been employed as an *anthelmintic.* For this purpose it is exhibited in large doses by the mouth, or, when the worms are lodged in the rectum, a strong solution is administered in the form of enema. When leeches have crept into the rectum, or have been accidentally swallowed, a solution of salt should be immediately used. As a *chemical antidote* chloride of sodium may be administered in poisoning by nitrate of silver. As an *alterative and tonic* it is useful in scrofula and glandular diseases. As an *astringent*, in hemorrhages, dysentery, and diarrhœa, it has been administered in combination with lime juice or lemon juice[q]. It is frequently used as a *dentifrice* (see p. 219).

As an *external application* salt has been used for various purposes. Thus, a saturated solution, applied with friction, is employed, as a counter-irritant and discutient, in glandular enlargements and chronic diseases of the joint; as a stimulant, it is rubbed on the chest in fainting and asphyxia. A solution of salt is employed for baths (cold and warm), affusion, the douche, &c. (See *Sea Water*, p. 263.)

Administration.—As a tonic and alterative, the dose of salt is from ten grains to a drachm. As an emetic, from two to three table-spoonfuls in five or six ounces of warm water. As a cathartic, from half an ounce to an ounce. In the form of clyster, it is used to the extent of two or even three table-spoonfuls. (See *Saline or Brine Waters*, p. 270.)

2. SO'DÆ HYPOCHLO'RIS.—HYPOCHLORITE OF SODA.

(Liquor Sodæ Chlorinatæ, *L.*)

History.—The disinfecting power of this substance was discovered by Labarraque about 1820[r]. In the French Codex this solution is called *Hypochloris Sodicus Aquâ solutus.* It is commonly known in the shops under the name of *Chloride of Soda, Liqueur de Labarraque,* or *Labarraque's Soda Disinfecting Liquid.* Other synonymes for it are *Chloruret of the Oxide of Sodium*, and *Oxymuriate of Soda.*

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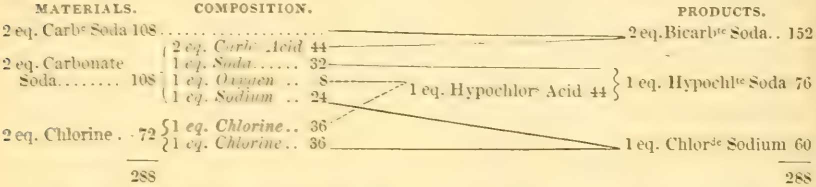
[m] *Ibid.* vol. x. p. 453.
[n] *Ibid.* p. 447.
[o] *Ibid.* vol. x. p. 717.
[p] Dr. Griffin, *Recollections of Cholera*, in *Lond. Med. Gaz.* vol. xxii. p. 319.
[q] *Memoir of the late Dr. Wright*, p. 322.

PREPARATION.—There are two methods in use for preparing a solution of hypochlorite of soda.

The following is the process of the *London Pharmacopœia* :—Take of Carbonate of Soda, lbj.; Distilled Water, f℥xlviij.; Chloride of Sodium, ℥iv.; Binoxide of Manganese, ℥iij.; Sulphuric Acid, ℥iv. Dissolve the Carbonate of Soda in two pints of Water; then put the Chloride of Sodium and Binoxide of Manganese, rubbed to powder, into a retort; and add to them the Sulphuric Acid, previously mixed with three fluidounces of the Water, and cooled. Heat (the mixture), and pass the Chlorine first through five fluidounces of the Water, and afterwards into the solution of the Carbonate of Soda above directed.

When chlorine gas comes in contact with a solution of carbonate of soda, three salts are formed: chloride of sodium, hypochlorite of soda, and bicarbonate of soda.



The essential and characteristic properties of this solution depend on the hypochlorite of soda. The changes which take place in the manufacture of chlorine have been already explained (p. 225).

In the *French Codex* this solution is directed to be prepared as follows:—Diffuse one part of dry chloride of lime (hypochlorite of lime) through 30 parts of water. Then add two parts of crystallized carbonate of soda, previously dissolved in 15 parts of water. Filter the mixture.

In this process a double decomposition is effected; hypochlorite of soda is formed in solution, while carbonate of lime precipitates. This process is more easy of execution than the previous one. By using the proportions here directed the solution is weaker than that prepared by the process of the London Pharmacopœia.

PROPERTIES.—The solution of hypochlorite of soda (*Liquor Sodæ Chlorinatæ*, L.) has a yellowish colour, an astringent taste, and an odour of hypochlorous acid. It destroys the colour of vegetable substances; as litmus, turmeric, and sulphate of indigo. Previous to bleaching them, it reacts as an alkali on turmeric paper, and infusion of red cabbage. By evaporation, crystals are obtained, which by re-solution in water re-produce the disinfecting liquid. By exposure to the air the solution undergoes decomposition, and crystals of carbonate of soda are formed.

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[r] Alcock, *Essay on the Use of the Chlorurets*, p. vi. Lond. 1827.

Characteristics.—The following are the essential characters of this solution:—

It decolorizes sulphate of indigo. On the addition of hydrochloric acid it evolves chlorine and carbonic acid. A solution of nitrate of silver throws down a white precipitate (*chloride of silver*), soluble in ammonia, but insoluble in nitric acid. Lime water causes a white precipitate (*carbonate of lime*). Oxalate of ammonia occasions no precipitate, showing the absence of lime. Bichloride of platinum produces no yellow precipitate, proving the absence of potash and ammonia. That the base of the solution is soda may be shown in two ways: evaporated to dryness, we obtain a residuum which renders the outer cone of the flame of a candle, or the flame of a spirit lamp, yellow; saturated with hydrochloric acid and evaporated to dryness, common salt is procured: this may be recognised by the characters before mentioned (p. 533).

Composition.—Some chemists regard this compound as a mixture of chloride of soda and bicarbonate of soda. But the view usually taken of it is that it consists of the *hypochlorite of soda*, *chloride of sodium*, and *bicarbonate of soda*.

Physiological Effects. *α. On Animals.*—A solution of the chloride of soda acts more or less powerfully as a local irritant, according to the degree of its concentration. From the experiments of Segalas[s] it appears, that, besides the irritant operation, and its direct and sympathetic action on the organic solids, it exercises an evident influence over the blood, and, in consequence, over the whole economy, by means of absorption. In an experiment referred to by Dr. Christison[t], two ounces of Labarraque's solution introduced into the peritoneum of a dog excited palpitation, oppressed breathing, constant restlessness, and death in ten minutes.

β. On Man.—I am unacquainted with any experiments made to determine the physiological effects of chloride of soda on man. That it would, *in large doses*, act as a powerful local irritant, and, if swallowed, give rise to symptoms of gastro-enteritis, cannot, I think, be doubted. Mérat and De Lens[u] state that the immediate consequence of, and predominating symptom produced by, a glassful of *Eau de Javelle* (a solution of chloride of potash) was general rigidity, which gave way to demulcent drinks. This observation agrees with one made by Segalas[v] in his experiments on dogs, namely, that chloride of soda caused tetanic spasms. It is probable, therefore, that the chlorides (hypochlorites) of the alkalis exercise a specific influence over the nervous system.

Chloride of soda, in *moderate or small doses*, has been denominated stimulant, tonic, astringent, antiseptic, and febrifuge. But these terms give no real explanation of the nature of those organic changes produced by it, whereby we obtain such benefit from its employment in various diseases. In fever, I have seen dampness of the skin follow its use. Increased secretion of urine is a common effect of it. In fevers it improves the qualities of the evacuations. Under the continued employment of it, glandular enlargements and chronic mucous discharges have disappeared, from which circumstance chloride of soda has been denominated alterative and resolvent. All these effects depend probably on the alteration which the chloride gives rise to in the condition of the blood, and the change thereby produced in the action of the different organs. We must not overlook the important fact that the solution of chloride of soda used in medicine contains bicarbonate of soda, to which perhaps in many cases its beneficial effects are, in part at least, to be referred.

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[s] *Journn. de Chim. Méd.* t. 1er. p. 271.

[t] *Treatise on Poisons*, 3d edit. p. 221.

[u] *Dict. Mat. Méd.* t. ii. p. 257.

[v] Christison, *op. cit.* p. 221.

Uses.—The solution of chloride of soda is employed as a *disinfectant*, *antiseptic*, and *antidote* (in cases of poisoning by the hydrosulphurets, and hydrosulphuric and hydrocyanic acids). But for most of these purposes the chloride of lime is employed instead of chloride of soda, since its properties are analogous, and being manufactured on a very extensive scale for the use of bleachers, it can be obtained more conveniently and cheaply. On this account, therefore, and to avoid repetition, I must refer to the article *Hypochlorite of Lime* for information respecting the above uses of chloride (hypochlorite) of soda. I would remark, however, that in several cases where I have carefully tried and compared the two chlorides (hypochlorites), I give the decided preference to the chloride of soda. As an antiseptic, Labarraque also preferred the latter preparation, on the ground that by the process of disinfection it becomes chloride of sodium, which is not a deliquescent salt; whereas the chloride of calcium generated by chloride (hypochlorite) of lime, attracts water from the atmosphere, and thereby furnishes one of the conditions (viz. moisture) necessary to the putrefactive process. Hence, in his opinion, while chloride of lime will serve equally well for mere disinfection, chloride of soda is preferable where we wish at the same time to prevent a renewal of putrefaction.

Chloride of soda is employed internally in all diseases commonly termed *putrid* or *malignant*, as typhus fever, scarlatina maligna, &c. It is indicated where there are great prostration of strength, fetid evacuations, and a dry and furred tongue. In such cases I have seen it of essential service, improving the quality of the secretions, producing a moist state of the skin, preventing collapse, and altogether acting most beneficially. It may be administered both by the mouth and the rectum.

There are many other diseases in which it has been administered internally with apparent success, but in which a more extended experience of its effects is required to enable us to place confidence in the results. I refer now to its employment as a substitute for the disulphate of quinia, in intermittents, recommended by Lalesque and

Gouzée[w]; to its use in the treatment of secondary syphilis, as practised by Dr. Scott[x], and by Cazenove[y]: to its administration in chronic skin diseases, and as a substitute for chlorine in bilious disorders, by Dr. Darling[z]; in scrofula, by Godier[a]; and in plague, by Neljoubin[b]. In some of these cases (as in syphilis and scrofula) the benefit obtained may have resulted from the bicarbonate of soda present in the chloride of the shops.

As a *local* remedy, we employ chloride of soda in all cases attended with fetid discharges, not merely as a disinfectant and antiseptic—that is, as a chemical agent destroying fetor, and preventing the putrefaction of dead matters (as gangrenous parts, the discharges from wounds and ulcers, &c.), though in these respects it is most valuable—but as a means of stopping or relieving morbid action by an impression produced on the living tissues. It frequently puts a stop to the further progress of gangrene; promotes the separation of the dead from the living parts; improves the quality of the secretions; and, at the same time, diminishes their quantity, when this is excessive. We apply it to ulcers of all kinds (whether common, phagedenic, cancerous, syphilitic, or scrofulous) when attended with foul discharges or a disposition to slough. We employ it with the greatest benefit in affections of the mucous surfaces. Thus it is used as a gargle to check ptyalism and ulceration of the mouth, whether arising from mercury or other causes. In scarlatina maligna we apply it to check ulceration and sloughing of the throat. In coryza and ozæna it has been injected into the nostrils with considerable benefit. In fetid and excessive discharges from the vagina, and neck of the uterus or bladder, it is employed as an injection with, at least, temporary relief. It has also been applied in some skin diseases, as tinea capitis, eczema, scabies, prurigo pudendi muliebris, &c. The above are only a few of the cases in which chloride of soda has been used with most marked benefit. In conclusion, I may add, that there are few, if any, remedies the uses of which, as local agents, are so valuable and extensive as the chlorides of soda and lime.

ADMINISTRATION.—The *liquor sodæ chlorinatæ*, Ph. L. may be administered internally in doses of twenty drops or more, diluted with three or four ounces of some mild aqueous liquid. When used as a *gargle*, it should be diluted with eight or ten parts of water: as an *injection* into the vagina, it is to be mixed with from fifteen to thirty parts of water: as a *lotion*, its strength must vary according to circumstances. In some sloughing ulcers I have used it mixed with its own volume of water, but in most cases it should, at the commencement of its use, be largely diluted, as with five or six parts of water. A *cataplasm* of chlorinated soda is prepared with linseed meal and equal parts of the liquor sodæ chlorinatæ and water.

ANTIDOTE.—(See *Calcis Hypochloris*.)

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[w] *Brit. and For. Med. Rev.* April, 1838.
[x] *Lond. Med. Rep.* N. S. vol. ii. 1836, p. 139.
[y] *Journ. de Chim. Méd.* t. iv. p. 140.
[z] *Lond. Med. Rep.* N. S. vol. ii.
[a] *Journ. Gén. de Méd.* 1829.
[b] Richter, *Ausf. Arzneim.* Suppl.-Bd. p. 539.

3. SO'DÆ SUL'PHAS, *L. E. D.*—SULPHATE OF SODA.

History.—Sulphate of soda (also called *Natron Vitriolatum*, *Glauber's Salt*, *Sal Catharticus Glauberi*, or *Sal Mirabile Glauberi*), was discovered in 1658 by Glauber.

Natural History.—It occurs in both kingdoms of nature.

α. In the Inorganised Kingdom.—As an efflorescence, the hydrous sulphate of soda is met with in various parts of the world. In the anhydrous state, mixed with a minute portion of carbonate of soda, it constitutes the mineral called *Thenardite*. Sulphate of soda is a constituent of many mineral waters; as those of Cheltenham, Leamington, and Spital (See p. 270).

β. In the Organised Kingdom.—It is found in the ashes of some plants which grow by the sea-shore; as the *Tamarix gallica*. Lastly, it is found in some of the animal fluids; as the blood and urine.

Preparation.—Sulphate of soda is a product of several processes, especially of the manufacture of hydrochloric acid.

The *London College* order of the salt which remains after the distillation of Hydrochloric Acid, lbij.; Boiling Water, Oij.; Carbonate of Soda as much as is necessary. Dissolve the salt in the water, add the marble so long as effervescence takes place, boil the liquid, and when neutral filter it; wash the insoluble matter with boiling water, adding the water to the original liquid; concentrate till a pellicle begins to form, and then let the liquid cool and crystallize.

The *Edinburgh College* order of the salt which remains, after preparing Pure Muriatic Acid, lbij.; Boiling Water, Oiij.; White Marble, in powder, a sufficiency. Dissolve the Salt in the Water, then gradually add as much Carbonate of Soda as is sufficient to saturate the Acid. Boil down until a pellicle appears, and the solution being strained, set it aside that the crystals may be formed. The liquor being poured off, dry them.

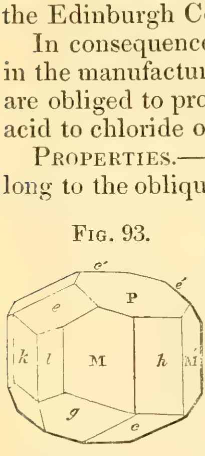
The directions of the *Dublin College* are as follows:—Let the salt which remains after the distillation of Muriatic Acid be dissolved in a sufficient quantity of hot water. Put aside the filtered liquor, that, after due evaporation, crystals may be formed by slow cooling.

The salt which remains after the distillation of hydrochloric acid is sulphate of soda usually contaminated with some free sulphuric acid, to neutralize which the London College uses Carbonate of Soda, the Edinburgh College, Marble (carbonate of lime).

In consequence of the enormous consumption of sulphate of soda in the manufacture of carbonate of soda, makers of the latter article are obliged to procure sulphate purposely, by the addition of sulphuric acid to chloride of sodium.

Properties.—It crystallizes in oblique rhombic prisms, which belong to the oblique prismatic system. To the taste this salt is cooling, and bitterish saline. By exposure to the air it effloresces. When heated it undergoes the watery fusion, gives out its water of crystallization, and thereby becomes a white solid, and at a red heat it again becomes liquid. One part of it dissolves in three parts of water at 60°, or one part of water at 212°. It is insoluble in alcohol.

Fig. 93.



Prism of Sulphate of Soda.

Characteristics. — Its constituents, sulphuric acid and soda, may be detected by the tests of these substances before mentioned (pp. 469 and 531). From the bisulphate of soda it is distinguished by its not reddening litmus, and by its less solubility. Crystals of anhydrous sulphate of soda are distinguished by their form being the rhombic octahedron, and by their not losing weight when heated.

Composition.—The ordinary crystals of sulphate of soda have the following composition:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*	*Wenzel.*
Soda	1	32	19·75	19·24	19·5
Sulphuric Acid	1	40	24·69	24·76	24·3
Water	10	90	55·56	56·00	55·2
Ordinary Crystals of Sulphate of Soda	1	162	100·00	100·00	99·0

Purity.—The crystallized sulphate of soda of the shops is usually sufficiently pure for medical purposes. The presence of chlorides in it may be detected by nitrate of silver.

> Exposed to the air it falls to powder. Totally dissolved by water; very slightly by alcohol. It does not alter the colour of litmus or turmeric. Nitrate of silver throws down scarcely any thing from a dilute solution; nitrate of barytes more, which is not dissolved by nitric acid. 100 parts of this salt lose 55·5 parts by a strong heat.—*Ph. L.*

Physiological Effects.—It is a mild but efficient cooling laxative or purgative salt, promoting secretion and exhalation from the mucous membrane of the stomach and bowels, without causing inflammation or fever.

Uses.—It is employed as a common purgative, either alone or added to other purgatives. It is applicable in fevers and inflammatory affections, where we want to evacuate the bowels without increasing or causing febrile disorder.

Administration.—The usual dose of it is from six to eight drachms. When dried so as to expel the water of crystallization, three and a half drachms act as an efficient purgative.

4. SO'DÆ BIBO'RAS, *L.*—BIBORATE OF SODA OR BORAX.

(Sodæ Boras, *E. D.*)

History.—Pliny[c] describes a substance under the name of *Chrysocolla*, which has been supposed by some to be biborate of soda. The term *Bauracon* or *Baurach* (from which our word *Borax* is derived) first occurs in the writings of the Arabians. By some of these authors (as Mesue and Avicenna) it was applied to nitre[d]: it is not improbable, however, that Geber[e] used it to indicate our borax. By modern chemists the salt has been termed *Biborate*, *Borate*, or *Sub-borate of Soda*.

Natural History.—Borax is a substance peculiar to the mineral kingdom. It has been found in some mineral waters; as those of San Restituta, in Ischia[f]. It occurs also in the waters of certain lakes, especially those of Thibet and Persia.

Preparation.—Borax is obtained in two ways:—1st, by refining native borax; 2dly, by saturating native boracic acid with soda.

a. By refining Tincal.—About fifteen days' journey north from

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[c] *Hist. Nat.* lib. xxxiii.

[d] Beckmann, *Hist. of Invent. and Discov.* vol. iv. p. 559.

[e] *Search of Perfection*, ch. iii.

[f] Gairdner, *On Mineral Springs*, p. 414.

Teeshoo Lomboo [Tissoolumboo], in Thibet, is a lake, said to be about twenty miles in circumference, and supplied by brackish springs rising from the bottom of the lake itself. In consequence of its high situation, during a part of the year this lake is frozen over. The water of it contains, in solution, both common salt and borax. The latter crystallizes on the edges and shallows of the lake, and is taken up in large masses, which are broken and dried[g]. It is stated that the natives mix it with an earth thinly covered with butter, to prevent the borax evaporating[h]!

It is imported, usually from Calcutta, under the name of *Tincal*[i] or *Crude Borax* (*Borax cruda* seu *nativa*), in the form of flattened six-sided prisms, coloured with a greasy unctuous substance, said, by Vauquelin, to be a fatty matter, saponified by soda; the colour is yellowish, bluish, or greenish. Mojon states that the greenish grey matter which surrounds some kinds of rough borax, contains native boron. Various methods have been contrived for refining borax: some calcine it, to destroy the fatty matter, others wash it with an alkaline solution (soda or lime), and then dissolve and crystallize. The product is called *Refined Borax* (*Borax depurata* seu *purificata*).

β. By saturating Native Boracic Acid with Soda.—The mode of preparing boracic acid in Tuscany has been already described (see p. 447). The rough acid usually contains from 17 to 20 per cent. of impurities (water, sulphates of ammonia, magnesia, lime, and alumina, chloride of iron, sal ammoniac, traces of sulphuretted hydrogen, clay, sand, sulphur, a yellow colouring matter, and an azotized matter soluble in alcohol). It is converted into borax in the following way:—Dissolve carbonate of soda in water contained in tubs, lined with lead, and heated by steam. Add greatly pulverulent boracic acid. The evolved gas is passed through sulphuric acid to detain any carbonate of ammonia which may be contained in it. Boil the liquor, and let it stand for 10 or 12 hours. Then draw it off into wooden crystallizing vessels lined with lead. Here *Rough* or *Crude Borax* is deposited. This is refined by dissolving it in water, contained in a tub lined with lead, and heated by steam; add carbonate of soda, and crystallize. The crystals are allowed to drain, and, when dry, are packed in chests. *Octohedral borax* is obtained by employing more concentrated solutions: it deposits at from 174 to 133 deg. F.[k]

PROPERTIES.—It usually occurs in large, colourless, transparent prisms, belonging to the oblique prismatic system (*Prismatic Borax*). It also occurs in octohedrons (*Octohedral Borax*). In commerce we frequently meet with it in irregular shaped masses. Its taste is saline, cooling, and somewhat alkaline. It reacts on tumeric paper like an alkali. By exposure to the air it effloresces slowly and slightly. When heated it melts in its water of crystallization, swells up, and forms a light, white, porous substance, called *Calcined Borax* (*Borax*

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[g] Turner's *Account of an Embassy to the Court of Teshoo Lama, in Thibet*, p. 406. Lond. 1800.
[h] Anderson's periodical called *The Bee*, vol. xvii. p. 22. Edinb 1793.
[i] From *Tincana*, the Sanscrit name for borax; Royle's *Essay on Medicine*, p. 97.
[k] Payen, *Ann. de Chém. et de Physique*, 3me Sér. tome ii. p. 322. Juillet 1841.

usta seu *calcinata*). At a higher temperature it fuses into a transparent glass (*Glass of Borax*), which is anhydrous borax. It is soluble in twelve parts of cold, or in two parts of hot water.

Characteristics.—Borax may be recognised by the following characters: it reddens turmeric paper; it fuses before the blowpipe into a glass, which may be readily tinged by various metallic solutions—thus, rose red by terchloride of gold, and blue by solutions of cobalt: if a few drops of sulphuric acid be added to powdered borax, and then spirit of wine, the latter will, when fired, burn with a green-coloured flame; lastly, if, to a strong hot solution of borax, sulphuric acid be added, boracic acid will be deposited in crystals as the liquid cools. The tests now mentioned for the most part only prove the salt to be a borate: the nature of the base is determinable by the tests for soda before described (p. 533).

COMPOSITION.—The following is the composition of borax:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*L. Gmelin.*	*Kirwan.*	*Berzelius.*
Soda	1	32	16·84	17·8	17	16·31
Boracic Acid	2	68	35·79	35·6	34	36·59
Water	10	90	47·37	46·6	49	47·10
Crystal^{d}. Prismatic Borax	1	190	100·00	100·0	100	100·00

Octohedral borax contains only five equivalents of water. It offers several advantages in the arts over the prismatic variety[l].

PHYSIOLOGICAL EFFECTS.—The effects of borax have been imperfectly ascertained. Its *local* action is that of a mild irritant: applied to sores it excites smarting, and, taken into the stomach in large doses, causes vomiting.

The *constitutional effects* are probably those of a mild refrigerant and diuretic. Wöhler and Stehberger detected it in the urine, so that it passes out of the system unchanged.

By some writers it is regarded as an agent exercising a specific influence over the uterus; promoting menstruation, alleviating the pain which sometimes attends this process, facilitating parturition, diminishing the pain of accouchement, and favouring the expulsion of the placenta and lochia[m]. Further evidence, however, is wanting to enable us either to admit or deny the supposed uterine influence of borax. Some recent English writers seem to entertain no doubt as to its promoting uterine contractions[n].

Borax has also been regarded as producing the effects of alkalis on the system; principally, I believe, from an erroneous notion that it was a subsalt[o]. When Homberg asserted that boracic acid was a sedative, borax was supposed to possess similar properties.

USES.—As a *local agent*, borax is employed, as a detergent, in aphthæ and ulceration of the mouth. In some skin diseases it has been used with benefit: as pityriasis versicolor, (called also *liver spots* or *chloasma*). A solution of it in rose-water is employed as a cosmetic. In gonorrhœa and leucorrhœa an aqueous solution has been occasionally used, as an injection, with success. Lastly, in the form of ointment (composed of ʒj. of borax to ℥j. of lard), it has been applied to inflamed and painful hemorrhoidal tumors.

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[l] Guibourt, *Hist. des Drog.* t. i. p. 191, ed. 3^{me}.

[m] Vogt's *Pharmakodynamik.*

[n] Dr. Copland, *Dict. of Pract. Med.* art. *Abortion*; and an anonymous reviewer in the *Brit. and For. Med. Rev.* for July, 1838, p. 86.

[o] Vogt, *op. cit.*; and Sundelin, *Heilmittellehre.*

Internally, it has been used to diminish the secretion of uric acid; to act as a diuretic in dropsical affections; and to influence the uterus in the cases before mentioned. Dr. Copland recommends it, in conjunction with ergot of rye, to promote uterine contractions.

Administration.—The dose of it is from half a drachm to a drachm. As a detergent in aphthæ it may be used in powder, mixed with sugar or with honey.

MEL BORACIS, L. E. D. *Honey of Borax; Mellite of Borax.* (Borax, powdered, ʒj.; Honey, [clarified, *L. D.*] ℥j.; Mix). A convenient form for the employment of borax in the aphthæ of children. Dissolved in water it may be employed as a gargle in ulceration of the mouth and throat.

5. SO′DÆ NI′TRAS.—NITRATE OF SODA.

History.—Duhamel[p], probably, was the discoverer of this salt, in 1736. It was first analyzed by Margraff[q] in 1761. It has been termed *Cubic*, *Quadrangular* or *Rhomboidal Nitre* (*Nitrum cubicum*, *quadrangulare* vel *rhomboidale*).

Natural History.—It is peculiar to the mineral kingdom.

Native nitrate of soda is found in South Peru. It exists in large beds, a few feet below the saline soil, or forming that soil in various places, from Arica on the north and west, to the course of the river Loa on the south. It is found in distinct strata, a thin layer of brown loam separating the parts[r].

Native nitrate of soda, in fractured masses, has a granular structure, arising from the aggregation of irregular rhombic crystals, varying from fine grained to coarse grained. Colour, from snow white to reddish brown or grey. Odour peculiar; and, when warmed, resembling chloride of iodine dissolved in water. Its average composition is *nitrate of soda*, 64·98; *sulphate of soda*, 3·00; *chloride of sodium*, 28·69; *iodic salts*, 0·63; *shells and marl*, 2·60 = 99·90[s].

Extraction.—"The richest masses of the native salt are blasted or broken, and divided into small portions; with these copper kettles are in part filled, and water, or the mother water of former operations, is added, and heat applied, until a boiling and saturated solution is obtained. The solution is transferred to wooden coolers, where the nitrate of soda crystallizes. The undissolved salt remaining in the kettles is thrown aside, fresh salt being used each time, although not one half of the nitrate of soda is dissolved. The coolers are emptied after the crystals of nitrate have ceased to form: it is dried, packed in bags, and sent to the coast on mules."

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[p] *Mémoires de l'Academie Royale des Sciences*, 1736, p. 215.

[q] *Opusc.* ii. 331.

[r] Hayes, in Silliman's *Journal;* also in *The Chemist*, for February, 1841, N°. xiv. p. 43. Rivero, in the *Edinb. Phil. Journ.* vol. vii. p. 184. Edinb. 1322.

[s] *Ibid.*

Commerce.—In 1839, duty (6d. per cwt.) was paid on 107,922 cwts. In 1840, on 130,211 cwts.[t]

Purification.—*Rough nitrate of soda* is purified, after its arrival in this country, by solution and re-crystallization.

Properties.—It usually crystallizes in obtuse rhombohedral crystals, which belong to the rhombohedral system. Its taste is somewhat bitter. In moist air it is slightly deliquescent. It is soluble in about two parts of cold water, and in less than its own weight at 212°. It fuses by heat.

Characteristics.—As a nitrate it is known by the characters of this class of salts already stated (p. 289). The nature of its base is recognised by the tests for soda already described (p. 533). The yellow colour which it communicates to flame, as well as the shape of its crystals, readily distinguish it from nitrate of potash.

Composition.—Crystallized nitrate of soda is anhydrous.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wenzel.*	*Longchamp.*
Soda	1	32	37·2	37·5	37·65
Nitric Acid	1	54	62·8	62·5	63·25
Crystallized Nitrate of Soda	1	86	100·0	100·0	100·00

Physiological Effects.—Its effects are similar to those of nitrate of potash. According to Wolfers[u], from two to four drachms of it may be taken daily without any hurtful effect. Velsen states, that it does not so readily disturb digestion as nitrate of potash.

Uses.—It is not employed in medicine in this country. As a substitute for nitrate of potash, it is used in the manufacture of nitric and sulphuric acids. It is employed by fire-work makers; and also as a manure, especially for wheat[v].

6. SO'DÆ PHOS'PHAS, *L. E. D.*—PHOSPHATE OF SODA.

History.—This salt was long known before its true nature was understood. In 1737, Hellot found it in the urine. It has been known by various names, such as *Alcali Minerale* and *Sal Mirabile Perlatum.* In the shops it is sold as *Tasteless Purging Salts.* Dr. Turner calls it *Triphosphate of Soda and Basic Water.* It is sometimes termed the *Rhombic Phosphate of Soda*, and not unfrequently *Neutral Phosphate of Soda.*

Natural History.—Phosphate of soda occurs in both kingdoms of nature.

α. In the Inorganised Kingdom.—It is a constituent of some mineral waters, viz. those of Steinbad at Toplitz, of Geilneu, Fachingen, Selters, and Neundorf[w].

β. In the Organised Kingdom.—It is a constituent of some animal fluids, as human urine.

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[t] *Trade List*, Jan. 5, 1841.

[u] Richter, *Ausführ. Arzneim.* Bd. iv. S. 251.

[v] *Journal of the Royal Agricultural Society of England*, for 1840 and 1841.

[w] Gairdner, *On Mineral Springs*, p. 19.

Preparation.—The Edinburgh and Dublin Colleges give each a formula for its preparation. The London College admits it as an article of the Materia Medica; that is, to be bought ready prepared.

The *Edinburgh College* orders of Bones burnt to whiteness, lbx.; Sulphuric Acid, Oij. and f℥iv.; Carbonate of Soda, a sufficiency; Pulverize the bones and mix them with the acid; add gradually six pints of water; digest for three days, replacing the water which evaporates; add six pints of boiling water, and strain through strong linen; pass more boiling water through the mass on the filter till it comes away nearly tasteless. Let the impurities subside in the united liquors, pour off the clear fluid, and concentrate to six pints. Let the impurities again settle; and to the clear liquor, which is to be poured off and heated to ebullition, add carbonate of soda, previously dissolved in boiling water, until the acid is completely neutralized. Set the solution aside to cool and crystallize. More crystals will be obtained by successively evaporating, adding a little carbonate of soda till the liquid exerts a feeble alkaline reaction on [reddened] litmus paper, and then allowing it to cool. Preserve the crystals in well-closed vessels.

The *Dublin College* orders of Bone Ashes, reduced to powder, *ten parts;* Sulphuric Acid, of commerce, *seven parts;* and carbonate of soda, dissolved in hot water, *eight parts.* The directions for conducting the process are essentially the same as those of the Edinburgh College.

The products obtained by the mutual reaction of sulphuric acid and bone-ash are sulphate of lime and superphosphate of lime (see p. 450); the latter remains in solution, while the former is, for the most part, precipitated. On the addition of carbonate of soda to the liquor, phosphate of soda is formed in solution, subphosphate of lime is precipitated, and carbonic acid gas escapes. A slight excess of carbonate of soda promotes the formation of crystals of phosphate.

Properties.—This salt crystallizes in oblique rhombic prisms, which are transparent, but by exposure to the air effloresce and become opaque. Their taste is cooling saline. They react feebly on vegetable colours like alkalis. When heated, they undergo the watery fusion, give out water, and form a white mass called *pyrophosphate of soda:* at a red heat this melts into a transparent glass, called *metaphosphate of soda.* The crystals of phosphate of soda require, for their solution, four times their weight of cold or twice their weight of hot water: they are nearly insoluble in alcohol.

Characteristics.—The presence of soda in this salt is known by the tests for this base before mentioned (p. 533). The phosphoric acid in it is recognised as follows: a solution of the phosphate throws down a white precipitate with acetate of lead, as well as with chloride of barium: the precipitate in both cases is a phosphate, and dissolves in nitric acid without effervescence: with nitrate of silver, the phosphate of soda occasions a yellow precipitate (*subsesquiphosphate of silver*, called by Graham *tribasic phosphate of silver*) soluble both in nitric acid and ammonia: pyrophosphate of soda, obtained by heating the phosphate, produces, with nitrate of silver, a white precipitate *(neutral phosphate of silver; pyrophosphate of silver; dipyrophosphate of oxide of silver):* hydrosulphuric acid, as well as the hydrosulphates, occasion no change in a solution of phosphate of soda. Phosphate of lead fuses upon charcoal, in the outer flame of the blowpipe, and becomes distinctly crystalline upon cooling.

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Soda	1	32	17.73	17·67
Phosphoric Acid	1	36	19·94	20·33
Water	12½	112·5	62·33	62·00
Crystallized Phosphate Soda	1	180·5	100·00	100·00

By Graham[x], Turner, and some other chemists, the equivalent weight of phosphoric acid is assumed to be about double (viz. 71·44) that which I have adopted. On this hypothesis, the above salt contains 2 equivalents of soda, and 25 equivalents of water. Of this quantity of water, 1 equivalent is assumed to be basic, and the remaining 24 equivalents to be water of crystallization: so that the following is the constitution of the salt: $HO, 2NaO, P^2O^5 + 24HO$.

IMPURITY.—As met with in commerce, this salt is usually tolerably pure.

Exposed to the air it slightly effloresces. It is totally dissolved by water, but not by alcohol. What is thrown down from the solution by chloride of barium is white: the precipitate by nitrate of silver is yellow, unless the phosphate has been previously made red hot. Both precipitates are soluble in nitric acid. *Ph. Lond.*

If the precipitate caused by the chloride of barium be not totally soluble in nitric acid, a sulphate is present. If that caused by nitrate of silver do not entirely dissolve in nitric acid, a chloride is present.

"An efflorescent salt: 45 grains dissolved in two fluidounces of boiling distilled water, and precipitated by a solution of 50 grains of carbonate of lead in a fluidounce of pyroligneous acid, will remain precipitable by solution of acetate of lead." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—In doses of an ounce, or an ounce and a half, it acts as a mild antiphlogistic purgative, like sulphate of soda. In small and continued doses it has been used with the view of altering the composition of the blood, and of promoting the deposition of phosphate of lime in the bones.

USES.—As a purgative it is employed in the diseases of children and delicate persons, in preference to other saline substances, on account of its slight taste and mild action on the stomach. It is well adapted for febrile and inflammatory disorders.

It is one of the substances which have been employed in cholera, to restore to the blood its deficient saline matters[y]. On account of the phosphoric acid which it contains it has been supposed to be particularly applicable in those diseases in which there is a deficiency of phosphate of lime in the bones. It has also been administered in diabetes.

ADMINISTRATION.—As a purgative it is given in doses of from six to twelve drachms. It is best taken in broth or soup. As an alterative the dose is one or two scruples three or four times a day.

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[x] The equivalent of phosphorus is, according to Graham, 31·44.

[y] Dr. O'Shaughnessy, *Report on the Chemical Pathology of the Malignant Cholera*, p. 54.

SOLUTIO SODÆ PHOSPHATIS, E. *Solution of Phosphate of Soda.* (Phosphate of Soda, [free of efflorescence], grs. clxxv.; Distilled Water, f℥viij. Dissolve the salt in the water, and keep the solution in well-closed bottles).—Used only as a test (see *Lithargȳrum, Plumbi Acetas, Plumbi Carbonas*, and *Magnesiæ Sulphas*).

7. SO'DÆ CAR'BONAS.—CARBONATE OF SODA.

History.—This salt, as well as the sesquicarbonate of soda, was probably known to the ancients under the term of *νίτρον*, or *nitrum*[z]. The *Salt Alkali*, or *Sagimen Vitri* of Geber[a] was a carbonate of soda: the word *Sagimen* is a corruption of the Hindee term *Sajjiloon*[b]. In modern times this salt has had various appellations, such as *Mild Mineral* or *Fossil Alkali, Aërated Mineral Alkali, Subcarbonate of Soda*, and *Natrum Carbonicum.*

Natural History.—This salt is peculiar to the inorganised kingdom.

It is found in crystals, or in the form of an efflorescent powder, in several parts of the world. According to Klaproth[c] it occurs at Debrezin, in Hungary, and Montenuovo, near Naples. Beudant[d] has analyzed three native carbonates of soda; one from Lac Blanc, in Hungary; a second from Egypt; and a third from Vesuvius. Carbonate of soda is a constituent of some mineral waters, which are, in consequence, termed *alkaline*, or, when they also contain a large excess of carbonic acid, *acidulo-alkaline*[e].

Preparation.—It may be procured from *Barilla*, from *Kelp*, or from *Sulphate of Soda.*

1. Preparation of Barilla.—The substance called *Barilla*, (*Sodæ Carbonas venale. Barilla*, D.) is an ash usually obtained by the combustion of plants belonging to the order *Chenopodiaceæ;* as the Salsolas, Salicornias, and Chenopodiums. These are cultivated on the coasts, and when ripe are cut, dried, and burned in heaps: the resulting ash is barilla. It is a hard greyish or bluish mass, not deliquescent, having an alkaline acrid taste, and a peculiar odour. It consists of *Carbonate* and *Sulphate of Soda, Sulphuret* and *Chloride of Sodium, Carbonate of Lime, Alumina, Silica, Oxide of Iron*, and *Carbonaceous matter* which has escaped combustion. The carbonate of soda is produced by the decomposition of the oxalate and other organic salts of soda contained in the plants before combustion. Several varieties of barilla are known in the market: they are distinguished by the names of the places from whence they are imported; namely, the Grand Canary and Teneriffe Islands, Alicant, Sicily, Carthagena, and the

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[z] Vide *Potassæ Nitras*, p. 506; also *Sodæ Sesquicarbonas.*
[a] *Invent. of Verity*, ch. iv.; and *Search of Perfection*, ch. iii.
[b] Dr. Royle, *Essay on Hindoo Medicine*, p. 41.
[c] Dr. Thomson, *Outlines of Mineralogy*, vol. i. p. 96.
[d] Necker, in his *Règne Minéral*, t. 2^{nde}, p. 667.
[e] See pp. 268 and 271.

East Indies. *Canary Barilla* is procured from *Salsola Kali*[f]; *Alicant Barilla* (*Soda Hispanica; Soda Alicantina*) is obtained from *Salsola sativa, Chenopodium setigerum,* and other species[g]. It yields from 25 to 40 per cent. of carbonate of soda. *Sicily Barilla* is procured principally from *Salsola sativa:* it furnishes, according to Fée[h], 55 per cent. of carbonate of soda. Of the *French Barillas* two only deserve notice; namely, that of Narbonne, obtained from *Salicornia herbacea,* and which yields 14 or 15 per cent. of carbonate; and that of Aiguemortes, called *Blanquette,* and which contains from 3 to 8 per cent. only of alkaline carbonate.

The importation of barilla has very much fallen off of late years, in consequence of the extraction of carbonate of soda from sulphate of soda. In 1827 the quantity imported was 326,239 cwts.[i]; whereas, in 1840, it was only 284 tons[j].

2. Preparation of Kelp.—Kelp (called by the French *Varec* or *Normandy Soda*) is procured by the combustion of cryptogamic plants of the order *Algaceæ.* According to Dr. Greville[k], the species most valued for this purpose are *Fucus vesiculosus, nodosus* and *serratus, Laminaria digitata* (see fig. 47, p. 233) and *bulbosa, Himanthalia lorea,* and *Chorda Filum.* These are burned in coffers of stone or in kilns. About 24 tons of sea-weed are required to produce one ton of kelp[l]. The resulting ash is kelp. As met with in commerce, it consists of hard, dark grey or bluish masses, which have an acrid caustic taste, and are composed of *Chloride of Sodium,* about five per cent. of *Carbonate of Soda* (formed by the decomposition of the oxalate and other organic salts of soda), *Sulphates of Soda* and *Potash, Chloride of Potassium, Iodide of Potassium* or *Sodium,* and *Insoluble* and *Colouring Matters.* By digesting kelp in a small quantity of water, and filtering and evaporating the solution, crystals of carbonate of soda may be procured. But as this salt can be procured at a lower price and of finer quality from artificial soda, kelp is now of little value as a source of soda. In the Orkney Islands, about 20,000 persons were, a few years since, occupied in the manufacture of kelp[m].

3. Preparation of Soda-Ash from Sulphate of Soda. — The principal manufactories are situated in the northern parts of the kingdom, and are conducted on a most extensive scale. The process adopted varies in some of its details in different places.

The sulphate of soda employed is, in part, obtained from manufacturers of chloride of lime, who procure a considerable quantity in the process for generating chlorine. But the greater part of it is made expressly, by adding sulphuric acid to common salt (chloride of sodium). The hydrochloric acid gas evolved in this process is highly injurious to vegetable and animal life[n], and various contrivances have been resorted to to prevent its escape into the atmosphere, as by absorbing it by water or lime. The sulphate of soda, reduced to powder, is usually decomposed by mixing it with an equal weight of ground chalk and half its weight of small coal ground and sifted, and heating the mixture in a very hot reverberatory furnace. During the operation it is frequently stirred. The product has a dark grey or blackish appearance, and is called *British Barilla* or *Ball Alkali*.

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[f] Loudon, *Encyclopædia of Agriculture.*

[g] Lagasca, quoted in De Candolle's *Phys. Vég.* p. 388.

[h] *Cours d'Hist. Nat.* t. 2nd, p. 488.

[i] *A General Statement of the Imports and Exports,* printed by order of the House of Commons, 24th Feb. 1829.

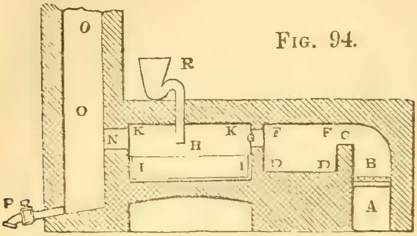
[j] *Trade List,* Jan. 5, 1841.

[k] *Algæ Britannicæ,* p. xxi.

[l] Macculloch's *Western Islands,* vol. i. p. 123.

[m] Greville, *op. cit.*

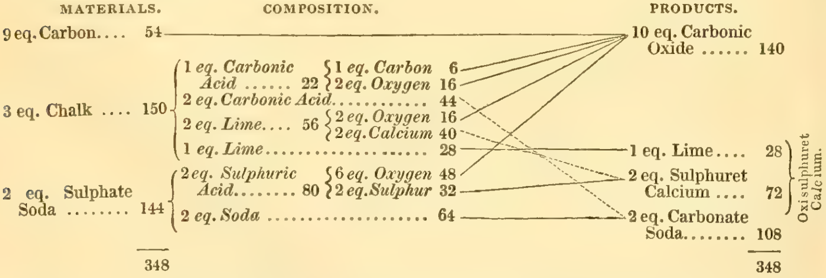
FIG. 94.



Furnace for converting Chloride of Sodium into Sulphate of Soda.

A. Ash-pit.
B. Grate.
C. Bridge.
D, D. First calcining hearth.
F, F. Its roof.
G. Second bridge.
I, I. Square lead pan.
K, K. Roof of decomposing hearth.
N. Third bridge.
O, O. Chimney filled with round flint nodules, kept continually moist by the trickling of a streamlet of water upon the topmost layer. The muriatic acid is absorbed by the water, and the solution escapes below at P.
R. Syphon funnel, by which the sulphuric acid is introduced.

It consists of carbonate of soda and oxisulphuret of calcium. During the operation carbonic oxide gas escapes. The following diagram explains the reactions:—



MATERIALS.	COMPOSITION.		PRODUCTS.	
9 eq. Carbon.... 54			10 eq. Carbonic Oxide 140	
3 eq. Chalk 150	*1 eq. Carbonic Acid* 22	*1 eq. Carbon* 6		
		2 eq. Oxygen 16		
	2 eq. Carbonic Acid........... 44			
	2 eq. Lime.... 56	*2 eq. Oxygen* 16		
		2 eq. Calcium 40		
	1 eq. Lime..................... 28		1 eq. Lime.... 28	Oxisulphuret Calcium.
2 eq. Sulphate Soda 144	*2 eq. Sulphuric Acid*........ 80	*6 eq. Oxygen* 48	2 eq. Sulphuret Calcium 72	
		2 eq. Sulphur 32		
	2 eq. Soda 64		2 eq. Carbonate Soda........ 108	
348			348	

By theory, the ball alkali should contain about 30 per cent. of carbonate of soda; but the quantity is in general only 22 per cent.

Ball alkali is lixiviated with water, and the carbonate of soda thereby separated from the more difficultly soluble oxisulphuret of calcium. The solution, by evaporation, yields a dark crystalline mass, composed of carbonate of soda, caustic soda, and some sulphuret of sodium. This is roasted in a reverberatory furnace, to get rid of the sulphur. Or it is calcined with sawdust. The product is called *soda-ash* or *soda-salt*, and contains about 50 per cent. of alkali[°].

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[n] See p. 275 et seq.—A very humorous account of the unpleasant effects of this gas is contained in the report of a trial at Lancaster, March 21, 1838, the Queen *v.* Airey, in the *Times* newspaper.

Purification.—The London and Dublin Colleges give directions for the purification of the impure carbonate of soda of commerce.

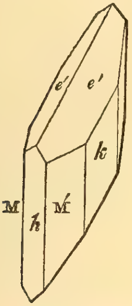
The *London College* orders of impure Carbonate of Soda, lb. ij.; Distilled Water, Oiv. Boil the impure carbonate of soda in the water, and strain it while hot. Lastly, set it by, that crystals may be formed.

The *Dublin College* directs Carbonate of Soda to be prepared from Barilla, in the same way. The operations are to be repeated until the crystals are sufficiently pure.

On the large scale crystallized carbonate of soda is obtained from Soda-ash by lixiviating the latter with water, straining the solution, and evaporating. The salt is usually crystallized in iron pans.

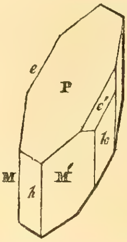
Properties. — Carbonate of soda usually forms large crystals, which are oblique rhombic prisms. They are transparent, and have a cooling alkaline taste. By exposure to the air they effloresce. When heated they undergo the watery fusion, and give out their water of crystallization: at a red heat, the whole of the water is expelled. Carbonate of soda is insoluble in alcohol. It dissolves in twice its weight of water at 60°, and in less than its own weight at 212° F. The solution reacts as an alkali on vegetable colours.

Fig. 95.



Ordinary Crystal.

Fig. 96.



Crystal reduced in height.

Characteristics.—As a carbonate it is known by the tests for this class of salts already stated (vide p. 334). From the bicarbonate it is distinguished by the brick-red precipitate which it throws down with bichloride of mercury. Sulphate of magnesia causes a white precipitate with it. As a soda salt it is recognised by the tests for this class of salts already stated (p. 533).

Composition.—The perfect crystals of the ordinary carbonate of soda of commerce have the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Klaproth.*
Soda	1	32	22·25	22
Carbonic Acid	1	22	15·25	16
Water	10	90	62·5	62
Crystallized Carbonate of Soda	1	144	100·00	100

[°] For further details consult Dumas, *Traité de Chimie*, t. ii.; Graham, *Elements of Chemistry*; Brande, *Manual of Chemistry*; Duncan, *Edinburgh Dispensatory*; and Ure's *Dictionary of Arts*.

Impurity.—The ordinary impurities of this salt are sulphates and chlorides. These are detected as follows:—Supersaturate with nitric acid, and then add, to separate portions of the diluted solution, chloride of barium and nitrate of silver: if the first occasion a white precipitate, it indicates the presence of a sulphate—if the second also produce a white precipitate, soluble in ammonia, but insoluble in nitric acid, it shews the presence of a chloride.

When freshly prepared it [Crystallized Carbonate of Soda] is translucent, but in an open vessel it in a short time falls to powder. It is totally soluble in water, but not at all in alcohol. It alters the colour of turmeric like an alkali. *Ph. L.*

"A solution of 21 grains in a fluidounce of distilled water, precipitated by 19 grains of nitrate of baryta, remains precipitable by more of the test; and the precipitate is entirely soluble in nitric acid. Little subject to adulteration." *Ph. Ed.*

Physiological Effects.—Carbonate of soda is less acrid, and has a milder and less unpleasant taste, than carbonate of potash; but in other respects the effects of these two salts on both vegetables and animals are the same.

Uses.—Carbonate of soda is used in the same cases as carbonate of potash, over which it has the advantage of a less disagreeable taste. Fourcroy imagined that as soda is contained in animals in larger proportion than potash, it was a better agent for medicinal use. Experience, however, has not confirmed this opinion, but has proved the reverse; for both Sir G. Blane[p] and Mr. Brande[q] state that they obtained beneficial effects, in calculous complaints, from the use of potash, where soda failed to give any relief. Sir G. Blane accounted for this by assuming that soda becomes applied to the purposes of the economy before it reaches the kidneys, whereas potash is carried to these organs in order to be thrown out of the system.

Administration.—Crystallized carbonate of soda is exhibited in doses of from ten grains to half a drachm or a drachm. It is sometimes employed in the manufacture of the effervescing draught.

20 grains of Crystallized Carbonate of Soda are saturated by about ..	9¾ grs. of Commercial Crystals of Citric Acid.
	10½ grs. of Crystals of Tartaric Acid.
	f℥ijss. of Lemon Juice.

Antidotes.—See *Potassa*, p. 486.

SODÆ CARBONAS EXSICCATA, L. *Sodæ Carbonas siccatum*, E. D. *Dried Carbonate of Soda.* Carbonate of Soda, lbj. Apply heat to the Carbonate of Soda in a proper vessel, until it is dried, and afterwards heat it to redness. Lastly, rub it to powder, *L.*—The processes of the *Edinburgh* and *Dublin Colleges* are essentially the same). Fifty-four grains of this preparation are equal to one hundred and forty-four grains of the crystallized carbonate. It may be exhibited either in powder or pills. Dose from grs. v. to ℈j.

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[p] *Transactions of a Society for the Improvement of Med. and Chirurg. Knowledge*, iii. 347.

[q] *Quarterly Journal of Science*, vol. vi. p. 205.

8. SO'DÆ SESQUICAR'BONAS, *L.*—SESQUICARBONATE OF SODA.

In the province of Sukena, near Tripoli, is found a substance which the Africans call *Trona*—a word from which are probably derived the terms *νίτρον*, *nitrum*, and *nitron*[r]. But the analyses of Klaproth[s], Phillips[t], and Beudant[u], show that the proportion of carbonic acid which it contains is that of a sesquicarbonate. From the analysis of MM. Mariano de Rivero and Boussingault[v] it appears that the substance termed *Urao*, and which occurs at the bottom of a lake at Lagunillas, near Marida, in South America, has a similar composition[w].

The white powder sold in the shops of this country for making *Soda Powders*, and which is denominated *Carbonate*, *Bicarbonate*, or *Sesquicarbonate of Soda* (*Sodæ Sesquicarbonas*, Ph. L.) consists either of bicarbonate of soda or of a mixture of carbonate and bicarbonate of soda, in varying proportions. The two latter substances may be detected as follows:—Wash the so-called sesquicarbonate with a small quantity of distilled water, and filter: the solution usually contains carbonate of soda (known by its throwing down a brick-red precipitate on the addition of a solution of bichloride of mercury)—while there remains on the filter bicarbonate of soda (recognized by its causing a white precipitate, or a slight milkiness or opalescence with a solution of bichloride of mercury). Sometimes the substance sold as sesquicarbonate of soda[x] consists wholly of bicarbonate.

The composition of native crystallized sesquicarbonate of soda is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Boussingault.* Urao.	*Klaproth.* Trona.
Soda	1	32	38·55	38·62	37·0
Carbonic Acid	1½	33	39·76	40·13	38·0
Water	2	18	21·69	21·24	22·5
Sulphate Soda	—	—	—	—	2·5
Native Sesquicarbonate Soda	1	83	100·00	99·99	100·0

Like the so-called hydrated sesquicarbonate of ammonia (pp. 310 and 311) it is probably a double salt, composed of one equivalent of the carbonate and one equivalent of the bicarbonate of soda.

9. SO'DÆ BICAR'BONAS, *E. D.*—BICARBONATE OF SODA.

History.—This salt was discovered by Valentine Rose. In some works it is termed *Natron Carbonicum perfecte saturatum seu acidulum.* Alone or mixed with carbonate of soda it constitutes the

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[r] Vide *Potassæ Nitras* and *Sodæ Carbonas.*
[s] *Beitrage*, iii. 83.
[t] *Quarterly Journal of Science*, vol. vii. 297.
[u] Quoted by Necker, *Règne Minéral*, ii. 668.
[v] *Ann. de Chim. et Phys.* xxix. 110.
[w] For an account of this lake, see *Quarterly Journal of Science*, vol. i. p. 188.
[x] For further details, see *Sodæ Bicarbonas.*

Sodæ Sesquicarbonas of the London Pharmacopœia,—the *Carbonate* or *Bicarbonate of Soda* of the shops.

NATURAL HISTORY.—It is a constituent of the mineral waters called *acidulo-alkaline*, as those of Carlsbad and Seltzer (see pp. 268 and 271).

PREPARATION.—All the British Colleges give formulæ for the preparation of bicarbonate or sesquicarbonate of soda.

The *London College* orders the sesquicarbonate to be prepared with Carbonate of Soda, lbvij.; Distilled Water, *Cong.* j. Dissolve the Carbonate of Soda in the Water, and strain; then pass Carbonic Acid into the solution to saturation, that the salt may subside. Wrapped and pressed in cloth dry this with a gentle heat.

The *Edinburgh College* orders the bicarbonate to be prepared as follows:—Fill with fragments of marble a glass jar, open at the bottom and tubulated at the top; close the bottom in such a way as to keep in the marble without preventing the free passage of a fluid; connect the tubulature closely by a bent tube and corks with an empty bottle, and this in like manner with another bottle filled with one part of Carbonate of Soda, and two parts of Dried Carbonate of Soda, well triturated together; and let the tube be long enough to reach the bottom of the bottle. Before closing the last cork closely, immerse the jar to the top in diluted muriatic acid contained in any convenient vessel; when the whole apparatus is thus filled with carbonic acid gas, secure the last cork tightly, and let the action go on till next morning, or till gas is no longer absorbed by the salt. Remove the damp salt which is formed, and dry it, either in the air without heat, or at a temperature not above 120°.

The *Dublin College* orders of Carbonate of Soda, *two parts;* Water, *five parts.* Dissolve. Let the liquor be exposed in a suitable apparatus to the stream of Carbonic Acid gas, which escapes during the solution of white marble in diluted Muriatic Acid, until it shall have ceased to absorb gas, and let it rest until crystals form: then, with a heat not exceeding 120°, let the liquor evaporate and crystals be formed by cooling; these are to be mixed with the former, dried and preserved in a close vessel.

"In the manufacture of this bicarbonate for the purpose of commerce, 160 lbs. of carbonate may be dissolved in 13 gallons of water, and carbonic acid thrown into the solution in a proper apparatus. The bicarbonate falls, as it forms, to the amount of about 50 lbs., and being separated from the solution, may be conveniently dried by pressure in an hydraulic press. A fresh portion of carbonate is dissolved in the mother liquor, and the operation repeated as before."[y]

The carbonic acid used in this process is usually procured artificially, by the action of diluted sulphuric acid on carbonate of lime. In some countries, however, it is obtained from natural sources; as at Vichy, where it is collected from the mineral waters[z].

Smith's process for the preparation of bicarbonate of soda consists in placing the ordinary carbonate of soda in a box, and surrounding it by an atmosphere of carbonic acid gas under pressure. As the bicarbonate combines with much less water of crystallization than is contained in the carbonate, a considerable portion of water is liberated, which, saturated with part of the salt, is allowed to drain off: when the gas ceases to be absorbed, the salt is taken out and dried.

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[y] Brande, *Manual of Chemistry*, 5th edit. 1841.

[z] For a description and sketch of the apparatus used in the collection of the gas by D'Arcet, see *Dict. de l'Indust.* 3me t. p. 61.

On examination it is found to have retained the original form of the pieces; but they have become of a porous and loose texture, presenting the appearance of numerous crystalline grains, aggregated together, and having a snow-white colour[a].

At Glasgow, sesquicarbonate [bicarbonate?] of soda is prepared by exposing the carbonate, dry, and in powder, to an atmosphere of carbonic acid gas: it absorbs the requisite quantity to be converted into a sesquicarbonate[b]. In the London Pharmacopœia for 1809, it was ordered to be prepared by adding the hydrated sesquicarbonate of ammonia to a solution of carbonate of soda, and applying a heat of about 100° F., to drive off the ammonia: the solution is then to be set aside to crystallize. The proportions of the ingredients employed were a pound of carbonate of soda, three ounces of sesquicarbonate of ammonia, and a pint of distilled water. Winckler[c] directs 4 parts of crystallized carbonate of soda, 1½ parts of sesquicarbonate of ammonia, and 10 parts of water. The proportions ordered by MM. Henry and Guibourt[d] are 6 parts of the crystallized carbonate of soda, 2 parts of sesquicarbonate of ammonia, and 4 parts of water.

PROPERTIES.—Perfect crystals of bicarbonate of soda are, according to Dr. Thomson[e], oblique rectangular prisms. As usually met with, this salt constitutes a white crystalline mass, or a whitish powder. In the latter state it is usually contaminated with a small portion of the carbonate. The taste of this salt, and its reaction on vegetable colours, are slightly alkaline. By exposure to the air it effloresces superficially. When heated it evolves carbonic acid and water, and becomes the anhydrous carbonate. It dissolves in 13 parts, according to Rose, or 8 parts, according to Berthollet, of cold water. By heat the solution loses first one-quarter, and subsequently one-half of its carbonic acid.

Characteristics.—To recognize the carbonic acid and soda of this salt, the tests are the same as before described (vide p. 553) for the carbonate of soda: From the latter salt the bicarbonate of soda is distinguished by its more difficult solubility in water, by its causing neither a brick-red precipitate with the bichloride of mercury, nor a white precipitate with the sulphate of magnesia of the shops.

COMPOSITION.—Crystallized bicarbonate of soda has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Rose.*	*Berthollet.*	*Bérard.*
Soda	1	32	34·04	37	31·75	29·85
Carbonic Acid	2	44	46·80	49	44·40	49·95
Water	2	18	19·14	14	23·85	20·20
Cryst. Bicarb. Soda	1	94	99·98	100	100·00	100·00

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[a] *Journ. of the Philadelphia College of Pharm.* vol. i., quoted by Dr. Bache, in the *United States' Dispensatory.* For a sketch of the apparatus employed by Souberain, in performing Smith's process, see his *Nouv. Traité de Pharm.* t. 2^{me}, pp. 289 & 284, 2nde ed. Paris, 1840.

[b] Dr. T. Thomson, *Athenæum* for 1840, p. 771.

[c] *Lehrb. d. Pharm. Chemie,* 1er Th. S. 292.

[d] *Pharm. Raisonnée,* t. 2nd, p. 409, éd. 2nde.

[e] *Chem. of Inorg. Bodies,* vol. ii. p. 54.

According to Dr. Thomson[f] this salt contains only one equivalent of water of crystallization.

Purity.—When quite pure this salt occasions no precipitate with bichloride of platinum, perchloric acid, or tartaric acid, by which its freedom from potash is demonstrated. When supersaturated with pure nitric acid, it gives no precipitate with either chloride of barium or nitrate of silver, by which the absence of sulphates and chlorides is shewn. Lastly, it occasions a white precipitate, or opalescence, with bichloride of mercury, by which the freedom from a simple or mono-carbonate is shewn.

It is totally dissolved by water. Neither chloride of platina nor sulphate of magnesia, unless heated, throws down any thing from this solution. By a strong fire it is converted into anhydrous carbonate of soda. *Ph. Lond.*

"A solution in 40 parts of water does not give an orange precipitate with solution of corrosive sublimate." *Ph. Ed.*

Physiological Effects.—The effects of this salt are analogous to those of bicarbonate of potash, than which it is regarded as having a somewhat less disagreeable taste and a slighter local action. It is less caustic and irritant than the carbonate of soda. Its remote or constitutional effects are analogous to those of the caustic alkalis. (Vide *Potassa*, p. 482.)

Uses.—It is employed as an *antacid* in those forms of dyspepsia which are attended with an inordinate quantity of acid in the stomach; as a *lithontriptic* in those kinds of lithiasis which are accompanied with an excessive secretion of uric acid and the urates; as a *resolvent* or *alterative* in certain forms of inflammation, in glandular affections, in syphilis, and scrofula; and as a *diuretic* in some dropsical complaints[g].

The principal consumption of bicarbonate of soda (*Sodæ Sesquicarbonas*, Ph. L.) is in the preparation of the effervescing draught, soda-powders, and Seidlitz powders: in these the bicarbonate is mixed with a vegetable acid (either citric or tartaric, usually the latter). Taken in a state of effervescence, a solution of this kind is an agreeable and refreshing drink for allaying thirst, checking sickness, and diminishing febrile heat, as I have before mentioned (see pp. 337, 409, and 413). The resulting soda-salt (tartrate or citrate) undergoes partial digestion in its passage through the system, and is converted into carbonate, which is found in the urine. Hence, therefore, these effervescing preparations may be employed as diuretics and lithontriptics, instead of the simple carbonate or bicarbonate of soda, than which they are more agreeable. On the other hand they are highly objectionable, and are to be carefully avoided, in the treatment of phosphatic deposits in the urine. Alluding to these cases, Dr. Prout[h] observes, "were I required to name the remedy calculated to do the most mischief, I should name the common saline draught, formed of potash or soda, and *some vegetable acid.*"

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[f] *First Principles of Chemistry*, vol. ii. p. 268.

[g] See *Potash*, p. 482, and *Carbonate of Soda*, p. 554.

[h] *Inquiry into the Nature and Treatment of Affections of the Urinary Organs*, 2d ed. p. 145.

Administration.—The dose of this salt is from ten grains to a drachm. In the preparation of effervescing draughts, a scruple of the powder sold in the shops as bicarbonate of soda (*Sodæ Sesquicarbonas*, Ph. L.) usually requires about 18 grains of crystallized tartaric acid, or about 17 grains of the ordinary crystals of citric acid, or four fluidrachms of lemon juice, to saturate it.

1. **PULVERES EFFERVESCENTES**, E. *Effervescing Powders.* (Tartaric Acid, ℥j.; Bicarbonate of Soda, ℥j. and grs. liv.; or, Bicarbonate of Potash, ℥j. and grs. clx. Reduce the acid and either bicarbonate separately to fine powder, and divide each into sixteen powders; preserve the acid and alkaline powders in separate papers of different colours).—The *Soda Powders* of the shops consist of 30 grains of bicarbonate of soda, contained in a blue paper, and 25 grains of tartaric acid, in a white paper. When taken they should be dissolved in half a pint of water. The flavour of the solution is improved by adding to the water, before dissolving the acid, one or two drachms of simple syrup, and either half a drachm of the tincture of orange-peel, or two or three drops of the essence of lemon. *Ginger-beer Powders* are made in the same way as soda powders, except that five grains of powdered ginger and a drachm of white sugar are mixed with the bicarbonate of soda.

2. **SEIDLITZ POWDERS.**—These consist of two drachms of Tartarized Soda and two scruples of Bicarbonate of Soda contained in a blue paper, and half a drachm of powdered Tartaric Acid in a white paper. These are to be taken dissolved in half a pint of water, while the liquid is in a state of effervescence. These form an agreeable and mild aperient. Why they are called *Seidlitz* powders I cannot divine, as they have no analogy to Seidlitz water.

3. **LIQUOR SODÆ EFFERVESCENS**, L. *Sodæ Aqua Effervescens*, E.; *Aqua Carbonatis Sodæ Acidula*, D.; *Effervescing Solution of Supercarbonate of Soda*; *Soda Water, properly so called.* (Sesquicarbonate [Bicarbonate, *E.*] of Soda, ʒj.; Distilled Water, Oj. Dissolve the carbonate in the water, and pass into it, compressed by force, more carbonic acid than is sufficient for saturation. Keep the solution in a well-stoppered vessel, *L. E.*—The process of the Dublin Pharmacopœia is essentially similar, except that carbonate of soda is substituted for the bicarbonate).—This solution is employed in the same cases as bicarbonate of soda. The additional quantity of carbonic acid contained in it renders it more agreeable, and not less effectual, as an alkaline agent, in its operation on the system generally. It is employed to counteract or prevent the inordinate secretion of uric acid and the urates; but both this and soda water powders are highly injurious in phosphatic deposits (see p. 558).

The *Bottled Soda Water* of the shops is in general only carbonic acid water (see p. 339). If, after it has ceased to effervesce, tartaric acid be added, the effervescence is not renewed unless an alkaline carbonate be present.

Liquor sodæ effervescens may be extemporaneously made, by pouring carbonic acid water into a tumbler containing half a drachm of bicarbonate of soda.

A fraudulent imitation of soda water is said to have been practised, by adding a few drops of sulphuric acid to a solution of carbonate of soda in water, and instantly corking the bottle. The fraud may be detected by chloride of barium, which throws down a white precipitate insoluble in nitric acid.

4. **SODÆ CARBONATIS AQUA**, D. *Solution of Carbonate of Soda.* (Take of Carbonate of Soda any required quantity; dissolve in water, and let the specific gravity of the liquor be to that of distilled water as 1021 to 1000. A liquor of the same specific gravity is prepared by dissolving an ounce of [crystallized] carbonate of soda in a [wine] pint of distilled water). Dose from fʒiij. to f℥ij.

5. **TROCHISCI SODÆ BICARBONATIS**, E. *Soda Lozenges.* (Bicarbonate of Soda, ℥j.; Pure Sugar, ʒiij.; Gum Arabic, ʒss. Pulverise them, and, with mucilage, beat them into a proper mass for making lozenges). Employed to relieve too great acidity of stomach.

10. POTAS'SÆ ET SO'DÆ TAR'TRAS, *E. D.*—TARTRATE OF POTASH AND SODA.

(Sodæ Potassio-Tartras, *L.*)

History.—This salt was discovered by Seignette, an apothecary at Rochelle, in 1672, and hence it is frequently termed *Seignette's Salt*, or *Sel de Seignette*[1]. He called it *Alkaline Salt*, *Sal Polychrest*, and *Rochelle Salt* (*Sal Rupellensis*). To distinguish it from the sal polychrest (sulphate of potash) of other writers, it is sometimes denominated *Sal Polychrestum Seignetti*. It is often called *Tartarised Soda* (*Soda Tartarizata* seu *Natron Tartarizatum*).

Preparation.—All the British Colleges give directions for its preparation.

The *London College* orders of Bitartrate of Potash, powdered, ℥xvj.; Carbonate of Soda, ℥xij.; Boiling Water, Oiv. Dissolve the carbonate of soda in the boiling water, and add gradually the bitartrate of potash. Strain the liquor; then apply a gentle heat until a pellicle floats, and set it aside that crystals may be formed. The liquor being poured off, dry them. Evaporate the liquor again that it may yield crystals.

The *Edinburgh College* orders the same quantities.

The *Dublin College* employs Carbonate of Soda, *five parts;* Bitartrate of Potash, reduced to the finest powder, *seven parts;* Hot Water, *fifty parts.*

In this process the excess of acid in the bitartrate of potash is saturated by the soda of the carbonate, while the carbonic acid of the latter is disengaged.

Properties.—This salt is met with in large, transparent, and regularly-shaped right rhombic prisms; but curiously enough, the crystals are frequently produced in halves (as in fig. 98). Their taste is mildly saline and bitter. Exposed to the air they slightly effloresce. When heated they undergo the watery fusion, evolve their water of crystallization, and are decomposed: the residue consists of charcoal and the carbonates of potash and soda. They are readily soluble in cold, and still more so in hot water.

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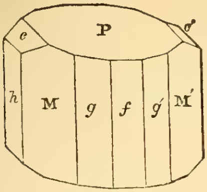
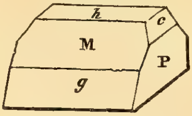
[1] Beckmann's *Hist. of Invent.* vol. iv. p. 616.

Fig. 97.



Prism of Rochelle Salt.

Fig. 98.



Natural Half of ditto.

Characteristics.—This salt may be recognized by the shape and size of the crystals. Sulphuric acid added to the aqueous solution throws down small crystals of bitartrate of potash; perchloric acid throws down perchlorate of potash: the chlorides of barium and calcium occasion white precipitates, soluble in excess of water, and composed of soda, tartaric acid, and, in the one case, baryta, in the other, lime: bichloride of platinum produces a yellow precipitate of the platinum-chloride of potassium. Heated with the bichloride of platinum it yields a black precipitate. Nitrate of silver occasions a white precipitate (*tartrate of silver*), soluble in excess of water. When heated, Rochelle salt is decomposed, various volatile substances are evolved, and the odour of caramel is given out (see p. 411). If the residuum be digested in hydrochloric acid, we obtain a solution of the chlorides of sodium and potassium: the chloride of potassium may be precipitated by bichloride of platinum, leaving chloride of sodium in solution, which may be detected by the tests already mentioned for this salt (p. 533).

Composition.—The composition of this salt is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Schulze.*			*Ats.*	*Eq.Wt.*
Soda	1	32	10·6	13·3		Tartrate Potash	1	114
Potash	1	48	15·6	14·3	or	Tartrate Soda	1	98
Tartaric Acid	2	132	43·7	41·3		Water	10	90
Water	10	90	29·8	31·1				
Crystl^{d} Tart^{e} of Potash & Soda	1	302	99·7	100·0			1	302

Dr. Thomson[i] says, that when the crystals are free from all adhering moisture, they contain only eight equivalents of water of crystallization, and their atomic weight is then 284.

Physiological Effects.—It is a mild, laxative, cooling salt, very analogous in its effects to the tartrate of potash. Sundelin[j] says it is uncertain as a purgative, sometimes failing, at others acting very slowly, but strongly, and with violent abdominal pain. He thinks it may be completely replaced in practice by a mixture of magnesia and sulphate of magnesia. Like the other vegetable alkaline salts, it undergoes partial decomposition in the system, and is converted into the carbonate, in which state it is found in the urine. Hence its use should be carefully avoided in persons suffering with phosphatic deposits in the urine.

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[i] *First Principles,* ii. 440.
[j] *Handb. d. Heilmittellehre.*

USES.—It is commonly employed as a mild aperient for females and other delicate persons. It may be used with advantage by those who are subject to excessive secretion of uric acid or the urates.

ADMINISTRATION.—It is given in doses of from ʒij. to ʒvj. or ℥j. It should be exhibited largely diluted with water. A very convenient mode of exhibition is in combination with bicarbonate of soda and tartaric acid in an effervescing condition (vide *Seidlitz Powders*, p. 559).

11. SO'DÆ ACE'TAS, *L. D.*—ACETATE OF SODA.

HISTORY.—This salt was first described by Baron, in 1747[k]: but according to Dulk[l] its real discoverer was F. Meyer, in 1677. It was formerly called *Terra Foliata Tartari Crystallisata*, or *Terra Foliata Mineralis*.

PREPARATION.—The preparation of acetate of soda by manufacturers of pyroligneous acid has been before described (see p. 393).

The *Dublin College* orders it to be prepared by saturating Carbonate of Soda with Distilled Vinegar. The filtered liquor is to be evaporated until it has attained the sp. gr. of 1·276. By cooling, crystals are formed, which are to be cautiously dried and kept in a close vessel.

PROPERTIES.—This salt crystallizes in oblique rhombic prisms. Geiger[m] says that a saturated solution of this salt does not readily crystallize when cooled in a tall glass vessel, unless some pointed or angular body be introduced. Its taste is cooling, saline, and bitterish. Exposed to the air, at ordinary temperatures, the crystals undergo little change; but in dry and warm air they effloresce and become anhydrous. When heated they first undergo the watery fusion, then give out their water of crystallization, and afterwards undergo the igneous fusion. At a red heat they are decomposed, and yield, as a residue, a mixture of charcoal and carbonate of soda. They are soluble in about three parts of cold water; and are slightly soluble in alcohol.

Characteristics.—As an acetate it is recognized by the tests before mentioned (p. 397) for this class of salts. That the base is soda is shewn by the characters already described (p. 533) for the soda salts.

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Soda	1	32	23·36	22·94
Acetic Acid	1	51	37·22	36·95
Water	6	54	39·41	40·11
Crystallized Acetate of Soda	1	137	99·99	100·00

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[k] Thomson's *Chemist. of Inorg. Bod.* vol. ii, p. 464.

[l] *Die Preuss. Pharm. übers. u. erläut.*

[m] *Handb. d. Pharm.* 1 Bd. 150, 3 Aufl.

PURITY.—It should be white and perfectly neutral to test-papers (litmus and turmeric). The presence of sulphuric acid may be recognized by chloride of barium, which occasions, with this acid, a white precipitate insoluble in nitric acid. If nitrate of silver cause a white precipitate insoluble in both water and nitric acid, but soluble in ammonia, the presence of a chloride is to be inferred. Potash may be recognized by the before-mentioned tests for this base (p. 481), as well as by the deliquescence of the suspected acetate.

PHYSIOLOGICAL EFFECTS.—Acetate of soda operates on the body like acetate of potash, but is probably somewhat milder in its action.

USES.—It is rarely employed for medicinal purposes. It may, however, be used as a substitute for acetate of potash, over which it has the advantage of not being deliquescent.

In pharmacy and the arts it is largely employed in the manufacture of acetic acid (vide p. 394), and on this account has been introduced into the Pharmacopœia, as the officinal source of this acid.

ADMINISTRATION.—The dose of it, as a diuretic, is from a scruple to two drachms.

12. SA'PO.—SOAP.

1. Sapo. Sapo ex olivæ oleo et sodâ confectus, *L.*—Sapo durus. Spanish or Castile Soap made with olive oil and soda, *E.*—Sapo durus, *D.*
2. Sapo mollis. Sapo ex olivæ oleo et potassâ confectus, *L.*—Sapo mollis. Soft soap made with olive oil and potash, *E.*—Sapo mollis, *D.*

HISTORY.—The Hebrew word *Borith*, translated in our version of the Bible[n] *Soap*, is, by most commentators, supposed to refer to a plant, or to the alkaline ashes of some plant. Pliny[o], who mentions soap, says it is made of tallow and ashes, ascribes its invention to the Gauls, and adds, that the Germans employed both thick and liquid soap (hard and soft soap?) In the excavations made at Pompeii, a complete soap-boiler's shop was discovered, with the soap still perfect, though it must have been manufactured for more than 1700 years[p].

The term *Soap* is usually applied to the product of the action of alkalis on fixed oils and fats: while the term *Plaster* is commonly applied to the product of the action of oxide of lead on fixed oils and fats. The former is frequently termed *a soluble soap*, while a plaster is denominated *an insoluble soap*. The term soap is also applied to alkaline resinates.

NATURAL HISTORY.—Soap is always an artificial product, unless the spontaneous formation of *adipocire*, from dead animal matter, be considered an exception to this statement. This substance appears, from the analysis of Chevreul, to consist of a small quantity of ammonia, of potash, and lime, united to much margaric acid, and a very little oleic acid.

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[n] *Jer.* ii. 22, and *Mal.* iii. 2.

[o] *Historia Naturalis*, lib. xxviii. cap. 51, ed. Valp. "Fit ex sevo et cinere." "Duobus modis, spissus ac liquidus."

[p] Parkes, *Chem. Essays*, ii. 5, 2nd ed.

PREPARATION.—The following is a concise account of the principles of soap-making :—"In order to form soap, the oil or fat is boiled with a solution of caustic potash or soda, till the whole forms a thick viscid emulsion, which can be drawn out into long clear threads. If not clear, either water or alkali must be added, according as the turbidity depends on undecomposed oil, or on a deficiency of water. When the saponification is complete, the next step is to separate the soap from the excess of alkali, the glycerine, and the superfluous water. This may be effected by boiling down till the alkaline ley becomes very concentrated, when the soap becomes insoluble, and rises to the surface. The same end is attained by adding very strong ley, or common salt, both of which render the soap insoluble when added in sufficient quantity ; soap being absolutely insoluble in alkaline ley of a certain strength, as well as in a saturated solution of common salt. The separation is known to be complete when the liquid ceases to froth in boiling ; and the soap is ladled off into moulds, where it is well stirred to favour the separation of the liquid, which should run off from its surface like water from fat. The soap brought to this state in the first operation is called *grain soap*, from its separating in grainy particles at first. It may be further purified by repeating the process of dissolving in alkaline ley, and separating it by the addition of salt. In this process the impurities subside, and the soap generally takes up more water : so that although whiter it is less strong. White soap, for example, commonly contains 45 to 60 per cent. of water, while grain soap contains 25 to 30 per cent. No doubt it may be again procured with as little water as at first ; but it is the fluidity caused by the additional water that allows the impurities to subside, and the soap to become white. What is called marbled soap is grain soap which has not been subjected to purification ; and the grey, blue, and green colours in it arise principally from the presence of insoluble soaps of oxide of iron or of copper[q]."

THEORY OF SAPONIFICATION.—The fixed oils and fats, as they occur in nature, are for the most part mixtures or compounds of two or more fatty salts. *Stearine*, *Margarine*, and *Oleine*, are the fatty salts of most frequent occurrence. They are each composed of a sweet basic substance, called *Glycerine* ($C^6 H^7 O^5 + Aq.$), and a fatty acid. Stearine contains *Stearic Acid* ($C^{68} H^{66} O^5$) ; while Margarine contains *Margaric Acid* ($C^{68} H^{66} O^6$) ; and Oleine, *Oleic Acid* ($C^{44} H^{39} O^4$).

Tallow consists chiefly of Stearine with a little Oleine. *Olive Oil* is composed of Margarine and Oleine. *Almond Oil* contains less Margarine than Olive Oil. *Palm Oil* contains Oleine, Margarine (?), and about two-thirds of its weight of a white solid fat, which is Palmitine, and which contains Palmitic Acid.

When the oils and fats are acted on by a solution of the caustic alkali, the latter unites with the fatty acid, forming a soap, and disengages the glycerine which combines with water.

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[q] Liebig, in Turner's *Elements of Chemistry*, 7th edit. p. 1076.

The following diagram illustrates the action of soda on stearine:—

MATERIALS.				PRODUCTS.	
4 eq. Soda........	128			2 eq. Stearate Soda....	1156
1 eq. Stearine	1129	*2 eq. Stearic Acid* ..	1028		
		2 eq. Water........	18	2 eq. Water	18
		1 eq. Glycerine	83	1 eq. Glycerine........	83
	1257				1257

In the conversion of resin into soap the phenomena are different. Resins usually consist of one or more acids, which combine with alkalis to form resinous salts or soaps. Thus, ordinary Yellow Resin (or Rosin) consists of two acids, called respectively Pinic and Silvic acids; and a soda soap made of this substance would, therefore, be a mixture of pinate and silvate of soda.

Properties.—The consistence, colour, odour, and sp. gr. of soap vary in the different varieties of this substance. The taste of all is slightly alkaline. All the alkaline soaps are soluble both in water and alcohol. The substance called *transparent soap* is prepared by evaporating an alcoholic solution of pure soap. When heated, soap fuses, swells up, and is decomposed, leaving a residuum of charcoal and alkaline carbonate. Most of the acids decompose soap: they unite with the alkaline base, and separate the fatty acids. The earthy salts (as sulphate of lime, sulphate of magnesia, alum, &c.) also decompose soap: the fatty acids unite with the earth to form an insoluble earthy soap, while the alkali of the soap combines with the acid of the salt. The *hardness* of sea, spring, and well water, depends on the earthy salts (principally sulphate of lime), which decompose soap (see p. 261): hence tincture of soap may be used as a test of the hardness or softness of common waters. The metallic salts decompose soap, and give rise to metalline insoluble soaps.

Characteristics.—Soap may be partly recognised by its physical properties, especially by its feel, which is so well known that it is usually called *soapy*. The solubility of soap in water and alcohol is an important character, as well as its detergent quality, which depends on its power of rendering fatty and other matters soluble in water. The effect of heat on it also deserves notice: if the carbonaceous residuum be digested in weak hydrochloric acid, and the solution filtered and concentrated by evaporation, the nature of the alkaline base may be ascertained by applying the tests for potash and soda before mentioned (pp. 481 and 533). Lastly, the action of acids and earthy and metallic salts on a solution of soap, as already noticed, serves to recognise soap.

Varieties.—A considerable number of soaps are met with in commerce. Of these, however, two[r] only are employed in medicine, viz. Castile Soap and Soft Soap.

The soaps of commerce are either *hard* or *soft;* the former are prepared with soda, the latter with potash. This circumstance, therefore, forms the ground of their division into two classes.

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[r] *Linimentum Ammoniæ* (p. 304) is an ammoniacal saponaceous liquid. *Linimentum Calcis*, hereafter to be described, is sometimes termed a calcareous soap (see *Calx*). *Emplastrum Plumbi* has also been called a soap.

Class I. Hard or Soda Soaps; *Sapo Sodaicus; Sapo natrinus; Sapo durus; Sapo spissus*, Pliny?—The qualities of the hard or soda soaps vary according to the nature of the fatty or resinous matters with which these substances are prepared.

1. Castile or Spanish Soap; *Sapo*, L.; *Sapo durus*, E. D.; *Sapo Hispanicus; Marseilles Soap; Olive Oil Soda Soap.*—This is prepared with olive oil and a solution of caustic soda. When pure it has very little odour. It is hard, but in the fresh state may be easily worked or kneaded between the fingers: by keeping in warm air it becomes dry and pulverizable. It should not feel greasy, have a rancid odour, communicate an oily stain to paper, nor be covered with a saline efflorescence; but should dissolve completely and readily in both water and alcohol.

Two varieties of it are known in commerce—the *white*, and the *marbled.*

α. *White Castile Soap.*—This is purer than the following variety, but it is a weaker soap (*i. e.* it contains more water).

β. *Marbled Castile Soap.*—This variety is harder than the white kind. The marbled appearance is produced by adding to the soap, as soon as it is completely made and separated from the spent lye, a fresh quantity of lye, and immediately after a solution of sulphate of iron. The black oxide of iron is precipitated, and gives the dark-coloured streaks to the soap. By exposure to the air these streaks become red, in consequence of the conversion of the black oxide into the red or sesquioxide of iron.

2. Almond Soap; *Almond-oil Soda-soap; Sapo amygdalinus*, French Codex.—This is the medicinal soap of the French. It is prepared with ten parts of soap-boilers' lye (a solution of caustic soda) and twenty-one parts of almond oil[s]. In this country it is used as a toilet soap.

3. Common Soap; *Sapo vulgaris*, United States Pharmacopœia; *Sapo sebaceus*, Geiger; *Animal-oil Soda-soap.*—This is prepared with tallow and soda. Two kinds of it are in common use, *curd soap* and *mottled soap.*

α. *White Curd Soap.*—This is made with pure or white tallow or curd soap. *Windsor Soap* is made with one part of olive oil and nine parts of tallow, and scented.

β. *Mottled Soap.*—This is the common or domestic soap. Refuse kitchen grease, called *kitchen stuff*, is used in its preparation.

4. Yellow Soap; *Rosin Soap; Resin Soda-soap.*—This is prepared with tallow, rosin, and caustic soda. Palm oil is frequently employed in its manufacture.

In addition to the above there are many varieties of soap, termed *Fancy* or *Toilet Soaps*, which are sold by perfumers. The patent *Silica Soap* is hard soap mixed with silicate of soda.

2. Of Soft or Potash Soaps; *Sapo potassicus; Sapo kalinus; Sapo mollis; Sapo liquidus*, Pliny?—This kind of soap is made with caustic potash and acid oil or fat.

1. Common Soft Soap; *Sapo mollis*, D.; *Animal-oil Potash Soap.*—This is prepared with fish oil (whale, seal, or cod), tallow, and potash. Its colour is brownish or yellowish; transparent, interspersed with white specks or grains of stearic soap formed by the tallow, and which give the soap a granular texture like that of the fig.

2. Olive-Oil Potash Soap; *Sapo mollis*, L. E.—Though ordered in the London and Edinburgh Pharmacopœias, I have not been able to meet with it; and Messrs. Rowe, soap manufacturers, of Brentford, inform me they are unacquainted with it[t].

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[s] Soubeiran, *Nouveau Traité de Pharmacie*, t. ii. p. 582, 2nde edit.

[t] Druggists generally substitute common soft soap for olive-oil potash-soap. At Apothecaries' Hall, London, a white soft soap is employed in the preparation of the *Unguentum Sulphuris Compositum*, L. This soap is prepared by Mr. Taylor, 13, Newington Causeway, who tells me there is very little demand for it, the principal consumption being at Apothecaries' Hall. He also informed me that it was made from three fatty substances (olive oil, tallow, and some other oil), and two alkalis (potash and soda). Its consistence is that of butter, but by keeping it becomes harder. I have been informed that olive-oil potash-soap is prepared at Liverpool.

Composition.—The following is the composition of several varieties of soap[u]:—

OLIVE OIL SODA SOAP.					
Marseilles white.			Marseilles marbled.	Foreign Castile, very dry.	London-made Castile, very dry.
Soda..........	10·24	6	6	9·0	10·5
Margaric Acid	9·20	60	64	76·5	75·2
Oleic Acid....	59·20				
Water........	21·36	34	30	14·5	14·3
Olive oil soda soap......	100·00	100	100	100·0	100·0
	(Braconnot.)	(D'Arcet.)	(Thenard.)	(Ure.)	(Ure.)

ANIMAL OIL POTASH SOAP	
Glasgow soft soap.	
Potash............	9·0
Fatty Acids	43·7
Water............	47·3
Animal oil potash soap	100·0
	(Ure.)

Purity.—The adulterations of soap are excess of water, lime, gypsum, or pipe-clay. The first may be known by the consistence of the soap, and the great loss of weight which this substance undergoes in dry air. The other impurities may be detected by alcohol, which leaves them undissolved.

Physiological Effects. α. *On Vegetables.*—Soap, used as a manure, appears to promote vegetation[x].

β. *On Animals.*—It does not appear to be poisonous to animals. Veterinarians employ it as a diuretic, and, in large doses, as a purgative.

γ. *On Man.*—Soap acts very much like the alkalis (*vide* pp. 194, 213, and 482). Its local operation, however, is much less energetic than either the caustic or even the carbonated alkalis. Hence it may be administered in considerable doses without causing irritation or inflammation. When swallowed it very readily palls the appetite and disturbs the digestive functions, and in these qualities it is more powerful than the alkalis. Perhaps these effects depend on the fatty acids which must be disengaged in the stomach, in consequence of the union of the alkali of the soap with the free acids of the gastric juice. Probably the fatty acids become more or less completely digested, for soap acts on the general system like the alkalis; it promotes the secretion of urine, and communicates alkaline properties to this fluid. In large doses it acts as a purgative. I knew an idiot who had frequently eaten large lumps of soap without any ill effects; and I have heard of a pound of it being swallowed for a wager!

Uses.—As an *antacid*, soap is employed in poisoning by the mineral acids: it should be administered in the form of a strong solution, which effectually neutralizes the acid without acting as an irritant. So also in those forms of dyspepsia which are attended with an excessive formation of acid, soap may be usefully employed to neutralize it. External parts burnt with the strong mineral acids, or with phosphorus, should be washed with a solution of soap. As a *lithontriptic*, soap has been used in those forms of lithiasis in which uric acid or the urates prevail. A mixture of soap and lime-water was once considered a most powerful solvent for urinary calculi. The Hon. Horace Walpole[y] gained great relief from it. By the action of lime-water on it, an insoluble calcareous soap and a solution of caustic soda are formed. As a *purgative*, soap is rarely exhibited alone: in combination with rhubarb it may be employed with considerable benefit in habitual constipation and disordered conditions of the biliary functions. In the form of enema, a strong solution of it is sometimes used with great relief to dissolve hardened fæces, and to relieve obstinate constipation. As a *resolvent* or *alterative*, it was once much esteemed in enlargements and various chronic disorders of the viscera and glands; and as the alkalis have been found useful in the same diseases, any good effects which may have been obtained by it are probably referrible to its alkaline base.

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[u] See Gmelin's *Handbuch der Chemie.*

[x] De Candolle, *Physiol Végét.* p. 1343.

Externally, soap is frequently employed on account of its detergent, lubricating, and discutient qualities. Thus, in tinea capitis, scabies, and various other skin diseases, ablution night and morning with soap-water greatly contributes to the cure. On account of its lubricating qualities it is a most convenient adjunct to liniments. The uses of the liniment, cerate, and plaster of soap, are noticed below.

Lastly, soap is useful in pharmacy to render other medicines more soluble, or to give a proper consistence to various substances for the making of pills. Thus it is a constituent of various pills (e. g. *Pilulæ Rhei compositæ; Pilulæ Saponis compositæ;* and *Pilulæ Scillæ compositæ*). In some cases it acts as the *adjuvans*, assisting and promoting the operation of other medicines; as a *corrigens*, correcting their operation; and, as a *constituens*, imparting an agreeable or convenient form. The addition of soap to aloes or extract of jalap is cited by Dr. Paris[z], as an instance in which soap fulfils all three of these objects.

ADMINISTRATION.—The usual dose of soap, taken in a pilular form, is from grs. v. to ʒss. In cases of poisoning by the mineral acids, half a pint of strong solution of soap should be instantly administered.

1. LINIMENTUM SAPONIS, L. E. D.; *Soap Liniment; Opodeldoc.* (Soap [Castile], ℥iij.; Camphor, ℥j.; Spirit of Rosemary, f℥xvj. *L. D.*—Castile Soap, ʒiv.; Camphor, ℥ij.; Volatile Oil of Rosemary, fʒv.; Rectified Spirit, Oj. and fʒxij. *E.*—The London College orders the camphor to be dissolved in the spirit, and the soap to be added afterwards: but the Edinburgh and Dublin Colleges direct the soap to be first dissolved, and the camphor [and oil, *E.*] subsequently. The Edinburgh College orders the mixture to be agitated briskly).—If made with hard soap, as directed by the Pharmacopœias, this preparation is apt to solidify in cold weather. On this account druggists usually substitute common soft soap. The only objection to this is its unpleasant smell.—Soap liniment is used as a stimulant and discutient, as well on account of its lubricating qualities, in local pains, sprains, bruises, rheumatism, &c. It is a constituent of *Linimentum Opii.*

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[y] *Philosophical Transactions*, xlvii. 43 & 472.

[z] *Pharmacologia.*

2. **CERATUM SAPONIS**, L. *Soap Cerate* (Soap, ℥x.; Wax, ℥xijss.; Oxide of Lead, powdered, ℥xv.; Olive Oil, Oj.; Vinegar, *Cong.* j. Boil the Vinegar with the Oxide of Lead, over a slow fire, constantly stirring them until they incorporate; then add the soap, and boil again in like manner, until all the moisture is evaporated; lastly, with these mix the Wax first dissolved in the Oil).—The subacetate of lead formed by boiling the oxide of lead with vinegar, is decomposed by the soap, the soda of which combines with the acetic acid, and the fatty acids with the oxide of lead. The wax and oil serve to give consistence to the preparation. It is used as a mild cooling dressing for scrofulous swellings, and other local inflammations, as well as for fractured limbs: in the latter case its principal use is as a mechanical support.

3. **EMPLASTRUM SAPONIS**, L. E. D.; *Soap Plaster.* (Soap, sliced, lbss.; Litharge Plaster, lbiij. *L. D.*—Litharge Plaster, ℥iv.; Gum Plaster, ℥ij.; Castile Soap, in shavings, ℥j. Mix the soap with the liquified plaster, and boil down to a proper consistence). The quantity of soap here ordered is said by Mr. Scanlan[a] to be too much by one half; as when prepared by the formula of the London and Dublin pharmacopœias it is quite pulverizable and falls into crumbs. The Gum Plaster ordered by the Edinburgh College will tend to obiviate this defect. Boiling is unnecessary. This plaster, spread on leather, is used as a discutient and mechanical support.

4. **EMPLASTRUM SAPONIS COMPOSITUM VEL ADHÆRENS**, D. *Adhesive Plaster.* (Soap Plaster, ℥ij.; Litharge Plaster with resin, ℥iij. Make a plaster, which should be melted and spread on linen).—This plaster is less apt to irritate than the litharge plaster with resin, "owing to the much smaller proportion of resin. It is a very useful application to those abrasions of the skin which take place in consequence of long confinement to bed."[b]

ORDER XIII. COMPOUNDS OF BARIUM.

1. BARY'TÆ SUL'PHAS, *E. D.*—SULPHATE OF BARYTA.

HISTORY.—Native sulphate of baryta, called *Ponderous* or *Heavy Spar* (*Spathum ponderosum*), was formerly confounded with sulphate of lime. In 1774 Scheele discovered baryta, and in the year following, Gahn analyzed heavy spar, and found that it was composed of sulphuric acid and baryta.

NATURAL HISTORY.—It is peculiar to the mineral kingdom.

It frequently occurs crystallized in forms belonging to the right prismatic system. The crystals are commonly tabular. The *Straight-lamellar Heavy Spar* forms splendid groups of crystals. It occurs in Cumberland, Durham, Westmorland, &c. The *Curved-lamellar Heavy Spar* is generally known as *Cock's Comb Barytes.* It is common in Scotland, Derbyshire, &c. *Compact* or *Earthy Sulphate of Baryta* occurs in Staffordshire and Derbyshire, and is called *Cawk.* The *Bolognese Spar,* from Monte Paterno, near Bologna, is *Radiated Sulphate of Baryta.*

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[a] Dr. Montgomery, *Observations on the Dublin Pharmacopœia*, p. 596.

[b] *Ibid.* p. 597.

PROPERTIES.—Sulphate of baryta has a density of from 4·41 to 4·67. It is inodorous and tasteless. When pure it is, in the pulverulent form, quite white. The form of its crystals has been above noticed.

"White or flesh-red; heavy; lamellar; brittle." *Ph. Ed.*

Characteristics.—Before the blowpipe it decrepitates, but is not easily fused. "This difficult fusibility constitutes a good mark of distinction between this mineral and sulphate of lime or of strontian[c]." Ultimately it melts into a hard white enamel. It is insoluble in nitric acid. Reduced to powder, mixed with charcoal, and ignited, it is converted into sulphuret of barium, which, on the addition of hydrochloric acid, evolves sulphuretted hydrogen (see p. 469), and yields a solution of chloride of barium (See the tests for this salt at p. 573).

COMPOSITION. — Sulphate of baryta has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Baryta	1	77	65·8	65·643
Sulphuric Acid	1	40	34·2	34·357
Sulphate of Baryta	1	117	100·0	100·000

PHYSIOLOGICAL EFFECTS.—According to the experiments of Orfila[d], it is inert.

USES.—Sulphate of baryta, on account of its cheapness, is the usual source from whence the other salts of baryta are obtained; and on this account it has been introduced into the Edinburgh and Dublin Pharmacopœias. In its pure state it is sometimes employed as a pigment.

2. BARY'TÆ CAR'BONAS, *L. E.*—CARBONATE OF BARYTA.

HISTORY.— In 1783, Dr. Withering recognized the native carbonate, which has, in consequence, been called, after its discoverer, *Witherite.*

NATURAL HISTORY.—It is peculiar to the mineral kingdom.

Witherite occurs in the lead-mines of the North of England; as of Anglesark, in Lancashire. *Baryto-Calcite,* a compound of carbonate of lime and carbonate of baryta, is met with at Alston Moor, Cumberland[e].

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[c] Dr. Thomson, *Outlines of Mineralogy, Geology, and Mineral Analysis,* vol. i. p. 104. Lond. 1836.

[d] *Toxicologie Générale.*

[e] For some curious anecdotes respecting its discovery at this place, see Parkes's *Chemical Essays,* vol. i. p. 324, 2d edit. London, 1823.

PREPARATION.—The native carbonate of baryta is sufficiently pure for the preparation of the other barytic salts, and is the kind meant in the London Pharmacopœia.

Absolutely pure carbonate may be prepared by the addition of a pure alkaline carbonate to a solution of chloride of barium.

It may also be obtained by igniting (or boiling in water) finely-powdered sulphate of baryta with three parts of carbonate of potash, or carbonate of soda, and washing away the resulting alkaline sulphate.

PROPERTIES.—Native carbonate of baryta occurs massive, stalactitic, and crystallized. Its crystals belong to the right prismatic system. The sp. gr. of this mineral is 4·3. Heated before the blowpipe it melts into a white enamel, with the evolution of much light and the loss of carbonic acid. Artificially prepared carbonate is a fine, tasteless, odourless powder. It is almost insoluble in both hot and cold water; 4,304 parts of cold, or 2,304 parts of hot water, being required to dissolve one part of carbonate. It is more soluble in carbonic acid water.

Characteristics.—It dissolves with effervescence in hydrochloric acid: the evolved gas is carbonic acid (see p. 334): the solution contains chloride of barium (see p. 573 for its characteristics).

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Berard.*
Baryta	1	77	77·7	77·9	78
Carbonic Acid	1	22	22·2	22·1	22
Carbonate Baryta	1	99	99·9	100·0	100

PURITY.—It should be white, odourless, tasteless, and entirely soluble in hydrochloric or nitric acid, by which its freedom from sulphate of baryta is demonstrated. Neither caustic ammonia nor hydrosulphuric acid should produce any precipitate or change of colour in the hydrochloric solution, by which the absence of alumina and metallic matter (lead or iron, or copper) may be inferred. If excess of sulphuric acid be added to this solution, the whole of the baryta is thrown down in combination with the acid, and no precipitate should be occasioned by the subsequent addition of carbonate of soda, by which the absence of lime is shown.

Totally soluble in diluted hydrochloric acid. This solution on the addition of ammonia or hydrosulphuric acid, does not give any precipitate, and it remains colourless; when more sulphuric acid is added than is necessary to saturation, nothing is afterwards thrown down by carbonate of soda.—*Ph. Lond.*

"One hundred grains dissolved in an excess of nitric acid are not entirely precipitated with sixty-one grains of [anhydrous] sulphate of magnesia [or one hundred and twenty-five grains of the crystallized sulphate of magnesia.]."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—Germination does not take place in carbonate of baryta[f].

β. On Animals.—Cows and fowls have been destroyed by swallowing the native carbonate[g]. Orfila[h] says a drachm of the powder killed a dog in six hours; but C. G. Gmelin[i] gave two drachms to a dog: vomiting took place, and the animal was well the next day. A drachm killed a rabbit in three hours. When applied to a wound it has proved fatal[j]. From the above experiments carbonate of baryta appears to act as an acro-narcotic poison: when swallowed it causes vomiting, inflames the alimentary tube, becomes absorbed, and acts specifically on the nervous system, causing convulsions, pa alysis, and insensibility.

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[f] Vogel, in De Candolle, *Phys. Végét.* p. 1341.
[g] Parkes, *Chem. Essays*, vol. i. p. 330.
[h] *Toxicol. Générale.*

. *On Man.*—Only one case illustrating its action on the human subject has been published[k]. A young woman swallowed half a tea-cupful of the powdered carbonate: in two hours she had dimness of sight, double vision, ringing in the ears, pain in the head, and throbbing in the temples, a sensation of distension and weight at the epigastrium, distension of stomach, and palpitation. Subsequently she had pains in the legs and knees, and cramps in the calves. A day or two after the cramps became more severe. These symptoms, slightly modified, continued for a long time.

USES.—Carbonate of baryta is employed in the preparation of the chloride of barium. It is not administered as a medicine.

ANTIDOTE.—(Vide *Barii Chloridum.*)

3. BA'RII CHLO'RIDUM, *L.*—CHLORIDE OF BARIUM.

(Barytæ Murias, *E. D.*)

HISTORY.—This compound was discovered by Scheele in 1775. It was at first termed *Terra Ponderosa Salita*, and afterwards *Muriate of Barytes.*

PREPARATION.—All the British Colleges give directions for the preparation of this salt.

The formula of the *London College* is as follows:—Take of Carbonate of Barytes, broken into small pieces, ℥x.; Hydrochloric Acid, Oss.; Distilled Water, Oij.—Mix the Acid with the Water, and add the Carbonate of Barytes gradually to them. Then, heat being applied, and the effervescence finished, strain and boil down the liquor, that crystals may be formed.

The *Edinburgh College* directs it to be prepared either in the same way as the London College, or as follows:—Take of Sulphate of Baryta, lbij.; Charcoal, in fine powder, ℥iv.; Pure Muriatic Acid, a sufficiency. Heat the sulphate to redness, reduce it to a fine powder, mix the charcoal with it thoroughly, heat the mixture in a covered crucible for three hours at a low white heat. Pulverize the product, put it gradually into five pints of boiling water; boil for a few minutes; let it rest for a little over a vapour-bath; pour off the clear liquor, and filter it if necessary, keeping it hot. Pour three pints of boiling water over the residuum, and proceed as before. Unite the two liquids; and while they are still hot, or, if cooled, after heating them again, add pure muriatic acid gradually so long as effervescence is occasioned. In this process the solutions ought to be as little exposed to the air as possible; and, in the last stage, the disengaged gas should be discharged by a proper tube into a chimney or the ash-pit of a furnace. Strain the liquor, concentrate it, and set it aside to crystallize.

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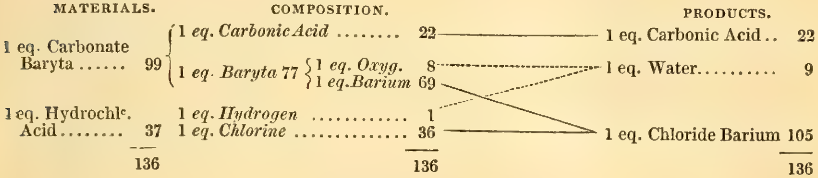
[i] *Versuche über d. Wirk. des Baryts*, &c. p. 8.
[j] Campbell, quoted by Christison, *Treatise on Poisons*, 3d ed. p. 532.
[k] Dr. Wilson, *Lond. Med. Gaz.* vol. xiv. p. 487.

The *Dublin College* also prepares it from the sulphate. The process is as follows :—Take of Sulphate of baryta, *ten parts ;* Charcoal, reduced to the most subtle powder, or of Lampblack, *one part.* Let the Sulphate of Baryta be roasted in the fire, and whilst red hot thrown into water ; then let it be reduced to the finest powder, in the manner directed for Prepared Chalk. Let the powders, intimately mixed together, be passed into a crucible, and exposed to a strong heat until they become red hot, during four hours. Let the mass, when cold, be dissolved in a quantity of boiling distilled water, amounting to ten times the weight of Sulphate of Baryta, and let the liquor be filtered. To this add, avoiding the vapours, as much muriatic acid as may be sufficient to saturate the baryta. Then let the liquors be filtered, from which, by evaporation and cooling, let crystals be formed.

When hydrochloric acid and carbonate of baryta are mixed together, one equivalent or 37 parts of hydrochloric acid react on one equivalent or 99 parts of carbonate of baryta : and the products are one equivalent or 22 parts of carbonic acid, which escape ; one equivalent or 9 parts of water, and one equivalent or 105 parts of chloride of barium.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Carbonate Baryta...... 99
1 eq. Carbonic Acid 22
1 eq. Baryta 77
1 eq. Oxyg. 8
1 eq. Barium 69
1 eq. Hydrochlc. Acid........ 37
1 eq. Hydrogen 1
1 eq. Chlorine 36
136
136
1 eq. Carbonic Acid.. 22
1 eq. Water.......... 9
1 eq. Chloride Barium 105
136

When a mixture of sulphate of baryta and charcoal is submitted to an intense heat, the carbon combines with the oxygen of the sulphuric acid and of the baryta, and forms carbonic oxide, which escapes. The residue digested in water forms a solution of sulphuret of barium. On the addition of hydrochloric acid, hydrosulphuric acid gas is evolved, and the solution by evaporation yields crystals of chloride of barium.

Properties.—Chloride of barium crystallizes in right rhombic plates or tables, sometimes in double eight-sided pyramids, which belong to the right prismatic system. To the taste this salt is disagreeable and bitter. Its sp. gr. is 2·825. In dry warm air the crytals effloresce, but in the ordinary states of the air they undergo no change. When heated they decrepitate, lose their water of crystallization, and at a red heat fuse. At a white heat, according to Planiava, this salt volatilizes. It is soluble in both cold and hot water : 100 parts of water at 60° dissolve 43·5 of the crystallized salt,—at 222°, 78 parts. It is slightly soluble in ordinary rectified spirit, but is said to be insoluble in pure alcohol.

Characteristics.—Nitrate of silver added to a solution of chloride of barium causes a white precipitate (*chloride of silver*) soluble in ammonia, but insoluble in nitric acid (see p. 226). As a barytic salt it is known by the following tests :—No precipitate is produced in a dilute solution of chloride of barium by ammonia, hydrosulphuric acid, or ferrocyanide of potassium. But the soluble sulphates, phosphate, and carbonates, occasion with chloride of barium white precipitates (which are respectively *sulphate*, *phosphate*, and *carbonate of baryta*). The sulphate of baryta is insoluble in nitric acid. Chloride of barium communicates a greenish-yellow tint to flame.

Composition.—Crystallized chloride of barium has the following composition:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*	*Phillips.*
Barium	1	69	56·09	85·201	85·5
Chlorine	1	36	29·26		
Water	2	18	14·63	14·799	14·5
Crystallized Chloride Barium	1	123	99·98	100·000	100·0

Purity.—The crystals should be colourless, neutral to test paper, permanent in the ordinary states of the air, (if they become moist or are deliquescent, the presence of chloride of calcium, or chloride of strontium, may be suspected), and their dilute aqueous solution should undergo no alteration of colour by the addition of ferrocyanide of potassium, hydrosulphuric acid, tincture of nutgalls, or caustic ammonia, by which the absence of metallic matter (as iron, lead, or copper) may be inferred. If excess of sulphuric acid be added, the filtered solution should be completely volatile when heated, and should occasion no precipitate on the addition of carbonate of soda, by which the absence of lime or magnesia is proved.

"Ninety grains in solution, acidulated with nitric acid, are not entirely precipitated by forty-nine [forty-four] grains of [anhydrous] sulphate of magnesia," [or ninety grains of crystallized sulphate] *Ph. Ed.*

It is unnecessary to acidulate with nitric acid, as the pure chloride is perfectly soluble in simple water.

Physiological Effects. *α. On Vegetables.*—This salt is poisonous to plants[l].

β. On Animals.—The action of chloride of barium on animals is, according to Sir B. Brodie[m], analogous to that of arsenic. Locally, it operates as an irritant. After absorption it affects the nervous system, the organs of circulation, and the stomach. Its action on the nervous system is manifested by staggering, convulsions, paralysis, and insensibility; on the circulating system, by palpitations, with feeble and intermittent pulse; on the stomach, by vomiting, from its application to a wound. According to Sir B. Brodie, the affection of the stomach is slighter than that caused by arsenic[n].

γ. On Man.—Administered in *small doses*, it at first produces no very obvious effects. In some cases the appetite appears to be improved. Soon we observe an increased secretion of urine, tendency to sweating, and not unfrequently loose stools; so that it appears to operate as a liquefacient (see p. 194). With no other obvious symptoms than these, glandular swellings or enlargements sometimes become softer and smaller: hence it is resolvent. If we persevere in the use of gradually augmented doses, the appetite becomes disordered, nausea and vomiting, with not unfrequently griping and purging, come on: a febrile state, with dry tongue, is produced, the nervous system becomes affected, and the patient complains of giddiness and muscular weakness. Sometimes, according to Schwilgué [o], under the continued use of it, catarrhal discharges from the eye, nose, ear, &c. take place; inflamed or suppurating lymphatic glands evince signs of an augmented excitation, wounds assume a more healthy appearance, and, in some cases, cicatrize.

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[l] Marcet, quoted by De Candolle, *Phys. Végét.*

[m] *Phil. Trans.* 1812, p. 205.

[n] See also the experiments of Orfila in the *Toxicol. Génér.*, and of C. G. Gmelin in his *Versuche über die Wirkungen*, &c.

In *large medicinal doses* very unpleasant effects have been occasionally observed from its use: such as vomiting, purging, sometimes griping, contracted pulse, giddiness, and great muscular debility, almost amounting to paralysis, with trembling [p].

In *excessive* or *poisonous doses* (as an ounce) the affection of the nervous system is more obvious. In one recorded case the symptoms were convulsions, pain in the head, deafness, and, within an hour, death [q].

In conclusion, it may be observed, that considered medicinally chloride of barium is most analogous to, though more powerful than, chloride of calcium, and is applicable in the same cases: regarded toxicologically, it may be compared to arsenic, but it acts less energetically on the stomach, and more rapidly on the nervous system, and causes death in a shorter time.

USES.—The principal medicinal use of chloride of barium is in the treatment of *scrofula*, for which it was introduced into medicine by Dr. Crawford in 1790 [r], and was subsequently used by Hufeland [s] with great benefit. The latter writer has employed it in all the forms of this disease, but especially in excited and inflamed conditions, (particularly of delicate and sensible parts, as of the lungs and eyes), in painful ulcers, indurations which are disposed to inflame, and cutaneous affections. It has also been administered as a resolvent, deobstruent, or alterative, in some other diseases; for example, *scirrhus* and *cancer*, *cutaneous diseases*, *bronchocele*, &c. As a local application, a solution of it has been used as a wash in herpetic eruptions, and as a collyrium in scrofulous ophthalmia.

In pharmacy and chemistry it is extensively employed as a test for sulphuric acid and the sulphates.

ADMINISTRATION.—It is used in the form of aqueous solution.

ANTIDOTES.—The antidotes for the barytic salts are the sulphates, which form therewith an insoluble sulphate of baryta. Hence sulphate of soda, sulphate of magnesia, alum, or well or spring water (which contains sulphate of lime) should be copiously administered.

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[o] *Traité de Mat. Méd.* vol. i. p. 441, 3^{me} ed.

[p] See an illustrative case in *Medical Commentaries*, xix. 267.

[q] *Journ. of Science*, vol. ix. p. 382.

[r] *Medical Commentaries*, Dec. 2d, vol. iv. p. 433; and *Medical Communications*, vol. ii.

[s] *Erfahr. üb. d. Gebr. u. d. Kräfte d. salzs. Schwererde*, Berl. 1794; and *Vollst. Darstell. d. med. Kräfte u. d. Gebr. d. salzs. Schwererde*, Berl. 1794.

Of course the poison should be removed from the stomach as speedily as possible. To appease any unpleasant symptoms caused by the continued use of large medicinal doses, opiates may be employed.

LIQUOR BARII CHLORIDI, L.; *Solutio Barytæ Muriatis*, E.; *Barytæ Muriatis Aqua*, D.; *Solution of Chloride of Barium.*—(Chloride of Barium, ʒj.; Distilled Water, f℥j.; *L. E.*—Muriate of Baryta, *one part;* Distilled Water, *three parts; D.* Dissolve.) Dose of the solution of the London Pharmacopœia, ten drops, gradually and cautiously increased until nausea or giddiness is experienced. It is employed also as a test for sulphuric acid or the sulphates. Common water, and all liquids containing sulphates, carbonates, or phosphates in solution, are incompatible with it.

4. BARY'TÆ NI'TRAS, *E.*—NITRATE OF BARYTA.

History.—This salt was formed soon after the discovery of baryta.

Preparation.—It "is to be prepared like the muriate of baryta [chloride of barium, see p. 572], substituting pure nitric acid for the muriatic acid."—*Ph. Ed.*

Properties.—It crystallizes in octohedrons. It is soluble in water, but insoluble in alcohol. It is decomposed, with decrepitation, by a bright red heat, and furnishes pure baryta.

Characteristics.—As a nitrate, it is known by the tests for this class of salts already mentioned (see p. 289). The characters of the barytic salts have been before stated (see p. 573).

Composition.—The crystallized salt is anhydrous. Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Baryta	1	77	58·7	58·8
Nitric Acid	1	54	41·3	41·2
Nitrate of Baryta	1	131	100·0	100·0

Physiological Effects.—Similar to those of the chloride of barium.

Uses.—It is employed as a test. Fire-work makers use it to communicate a green tinge to flame.

SOLUTIO BARYTÆ NITRATIS, E. *Solution of Nitrate of Baryta.* (Nitrate of Baryta, 40 grs.; Distilled Water, 800 grs. Dissolve the salt in the water; and keep the solution in well-closed bottles.) Employed as a test for sulphuric acid.

Order XIV.—COMPOUNDS OF CALCIUM.

1. CALX, *L. E.*—LIME.

(Calx recens usta, *D.*)

History.—Lime, and the mode of obtaining it by burning the carbonate, were known in the most remote periods of antiquity.

Hippocrates[t] employed this earth in medicine. Dr. Black, in 1755, first explained the nature of the process for making it. In 1808 Davy shewed that this substance was a metallic oxide, and hence it has been termed the *Oxide of Calcium*. To distinguish it from the hydrate of lime, it is called *Caustic Lime*, or *Quicklime* (*Calx viva*), or *Burned Lime* (*Calx usta*).

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—In the mineral kingdom lime is found in the form of carbonate, sulphate, phosphate, silicate, arseniate, tungstate, borate, and titanate. Its base, calcium, occurs in combination with fluorine. "Lime is also disseminated through sea water, though in small quantities; so that calcium is widely distributed in land and water, being principally abundant in the central and higher parts of the fossiliferous rocks, and widely dispersed, in small quantities, throughout the more ancient rocks, and in the waters of the ocean[u]."

β. IN THE ORGANISED KINGDOM.—In vegetables, lime (or calcium) is an invariable ingredient, except, it is said, in the case of *Salsola Kali*[v]. It is found combined with carbonic, sulphuric, phosphoric, nitric, and various organic acids (as oxalic, malic, citric, tartaric, and kinic): calcium occurs in combination with chlorine. In animals, lime is found principally as carbonate and phosphate.

PREPARATION.—For use in the arts lime is usually obtained by burning the carbonate with coals, coke, and other fuel, in a kind of wind furnace called a *kiln*[w].

All the British Colleges admit, as officinal, the lime of commerce; but the London and Edinburgh Colleges also give directions for the preparation of pure lime.

The *London College* orders of Chalk, lbj. Break it into small pieces, and burn it in a very strong fire for an hour.

The *Edinburgh College* orders White Marble, broken into small fragments, to be heated "in a covered crucible at a full red heat for three hours, or till the residuum when slaked and suspended in water no longer effervesces on the addition of muriatic acid."

By the heat employed the carbonic acid of the carbonate is expelled. It is well known that water or a current of air facilitates the escape of the carbonic acid: their effect is probably mechanical, and is due to the diffusion of one gas or vapour in another[x]. Iceland Spar or White Carrara Marble yields the purest lime.

PROPERTIES.—Lime (commonly termed *Quicklime*) when pure is a white or greyish solid, having a sp. gr. of 2·3. A variety of commercial lime has a grey colour, and is called *grey lime*. Lime has an acrid, alkaline taste, and reacts powerfully on vegetable colours as an alkali. It is difficult of fusion: but by the oxy-hydrogen flame it may be both fused and volatilized. Exposed to the air it attracts water and carbonic acid. If a small portion of water be thrown on lime, part of it combines with the lime, and thereby causes the evolution of a considerable degree of heat, by which another portion of the water is vaporized. The lime swells up, cracks, and subsequently falls to powder: in this state it is called *Slaked Lime (Calx extincta)*, or the *Hydrate of Lime* (*Calcis Hydras*, L.) By heat the water may be again expelled. Lime is slightly soluble in water. Its solubility in this liquid is very remarkable; cold water dissolving more than hot. According to Mr. Phillips,

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[t] *Popularium*, ii. sect. 5.

[u] De la Beche, *Research. in Theor. Geol.* p. 21.

[v] De Candolle, *Phys. Végét.* p. 382.

[w] Vide Loudon's *Encycl. of Agricult.* 3d ed. p. 625; Gray's *Operative Chemist*; and Ure's *Dict. of Arts.*

[x] See Gay-Lussac, in Jameson's *Journal*, vol. xxii. 1837.

A pint of Water at	32°	dissolves	13·25	grains of lime.
Ditto	60°	......	11·6	ditto.
Ditto	212°	......	6·7	ditto.

So that water at 32° dissolves nearly twice as much lime as water at 212°.

Characteristics.—An aqueous solution of lime is recognized by its reddening yellow turmeric paper, and rendering the infusion of red cabbage green; by the milkiness produced in it on the addition of carbonic acid or a soluble carbonate, and by the white precipitate *(oxalate of lime)* on the addition of a solution of oxalic acid or an oxalate. Sulphuric acid affords no precipitate with lime water. Solutions of the calcareous salts are known by the following characters:—The hydrosulphurets, and, if the solution be dilute, the sulphates, occasion neither a precipitate nor a change of colour: the soluble carbonates, phosphates, and oxalates, produce white precipitates. The calcareous salts (especially chloride of calcium) give an orange tinge to the flame of alcohol.

COMPOSITION.—The following is the composition of lime and its hydrate:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Calcium ..	1	20	71·42	71·91
Oxygen ..	1	8	28·57	28·09
Lime	1	28	29·99	100·00

	Atoms.	*Eq. Wt.*	*Per Cent.*
Lime	1	28	75·67
Water	1	9	24·32
Hydrate of Lime....	1	37	99·99

PURITY.—The lime used in the arts is never absolutely pure, but usually contains variable quantities of carbonate of lime, silica, alumina, and oxide of iron, and sometimes magnesia.

Water being added it [lime] cracks and falls to powder. Its other properties are as hydrate of lime. *Ph. L.*

It is slaked by water: muriatic acid then dissolves it entirely, without any effervescence; and the solution does not precipitate with ammonia.

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Quicklime is poisonous to plants. Notwithstanding this, however, it is used as a manure, its efficacy depending on its decomposing and rendering soluble the vegetable matter of the soil, during which the lime attracts carbonic acid and becomes innocuous[y].

β. On Animals.—On dogs, Orfila[z] found that quicklime acted as a caustic poison, but not very energetically; and that it occasions death by producing inflammation of the texture with which it comes in contact.

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[y] Davy, *Agricult. Chemistry.*

[z] *Toxicol. Générale.*

γ. *On Man.*—Quicklime, like the fixed alkalis, is a powerful escharotic. Its use in promoting the decomposition of the bodies of persons who have died of contagious diseases, or on the field of battle, and its employment by the tanner to separate the cuticle and hair from skins, sufficiently establish its causticity. Its escharotic and irritant action is well seen in the ophthalmia produced by the lodgment of small particles of lime in the eye.

When applied to suppurating or mucous surfaces, lime water checks or stops secretion, and produces dryness of the part: hence it is termed a desiccant. In this it differs from the fixed alkalis.

When administered internally, it neutralizes the free acid of the gastric juice, diminishes the secretions of the gastro-intestinal membrane, and thereby occasions thirst and constipation. It frequently gives rise to uneasiness of stomach, disordered digestion, and not unfrequently to vomiting. After its absorption it increases the secretion of urine, and diminishes the excessive formation or deposition of uric acid and the urates. With this exception, it does not, as the alkalis, promote the action of the different secreting organs, but, on the other hand, diminishes it, and has in consequence been termed an astringent. But it does not possess the corrugating action of the astringent vegetables, or of many of the metallic salts: it is rather a drying remedy, or desiccant. In this respect lime differs from the alkalis, but is analogous to the oxide of zinc (see p. 216). Vogt[a] considers it to be intermediate between the two. Weickard and others have ascribed to lime an antispasmodic property: and if this be true, its relation to zinc is still further proved.

A power of exciting and changing the mode of action of the absorbent vessels and glands has been ascribed to lime water, and probably with foundation. At any rate, under the use of it, glandular enlargements have become softer and smaller. In other words, it operates as a resolvent. Sundelin[b] says that the excessive use of lime does not, as in the case of the alkalis, bring about a scorbutic diathesis, but a general drying and constriction, analogous to that caused by zinc.

Lime, in large doses, acts as a poison: the symptoms in one case were thirst, burning in the mouth, burning pain in the belly, obstinate constipation, and death in nine days[c].

Uses.—Quicklime has been employed as a *caustic*, but alone is now rarely resorted to. It is sometimes applied in the form of *Potassa cum Calce* (see p. 488), and is a constituent of the ordinary depilatories (see p. 218). As an *antidote*, lime water, in conjunction with milk, was recommended by Navier[d] in poisoning by arsenious acid. In the absence of more appropriate antidotes, lime water may be administered in poisoning by the common mineral and oxalic acids. As a *lithontriptic* it possessed at one time considerable celebrity, partly from its being one of the active ingredients of Miss Joanna Stephens'

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[a] *Pharmakodynamik.*

[b] *Heilmittellehre.*

[c] Christison, *Treatise on Poisons.*

[d] *Contre-poison de l'Arsenic*, &c. 1777, quoted by Richter, *Ausf. Arzneimittellehre.*

Receipt for the Stone and Gravel, as well as from experiments and reports of professional men. As this lady had acquired no slight fame by her mode of treatment, a great desire was manifested to know the nature of her remedies, and she therefore offered to discover them on the payment of a suitable reward. A committee of professional men was appointed to examine the efficacy of her treatment, and her medicines were given to patients known to have calculi. The report made by the committee[e], as to the effects, was so favourable, that Parliament was induced to grant a reward of £5000, a notice of which appeared in the *London Gazette* of March 18, 1739[f]! The essential parts of her remedies were lime (prepared by calcining egg-shells and snails), soap, and some aromatic bitters; viz camomile flowers, sweet fennel, parsley, and burdock leaves, &c.[g] That the patients submitted to treatment obtained relief by the remedies employed cannot, I think, be doubted, but no cure was effected; that is, no calculus was dissolved, for in the bladder of each of the four persons whose cure was certified by the trustees, the stone was found after their death[h]. Notwithstanding the favourable reports to the contrary[i], it appears to me that no rational ground of hope can now be entertained that lime water is capable of dissolving urinary calculi in the kidneys or bladder: but there is abundant evidence to prove that patients afflicted with the uric acid diathesis have sometimes experienced extraordinary benefit from its use[j]. Chevallier [k] accounts for its efficacy in the treatment of gravel and stone by the circumstance of the combination of the lime with uric acid forming a very soluble salt, viz. urate of lime; and he even thinks that lime water may be useful in phosphatic calculi, either by depriving them of a portion of the uric acid which they contain, and thus rendering them less dense; by decomposing the ammoniacal salt which enters into the composition of some; or by acting on the animal matter which holds the molecules of these calculi together. As an *antacid* in dyspepsia, accompanied by acidity of stomach, it is sometimes useful. "Mixed with an equal measure of milk, which completely covers its offensive taste, it is one of the best remedies in our possession for nausea and vomiting dependent on irritability of stomach. We have found a diet, exclusively of lime water and milk, to be more effectual than any other plan of treatment in dyspepsia, accompanied with vomiting of food. In this case one part of the solution to two or three of milk, is usually sufficient[l]." In the dyspepsia of gouty and rheumatic subjects, and which is usually accompanied with a copious secretion of uric acid by the kidneys, I have seen lime water serviceable. As a *desiccant* or *astringent*, it is useful as a wash for ulcers attended with excessive secretion. In some scrofulous ulcers in which I have employed it, its power of checking secretion has been most marked. In diarrhœa, when the mucous discharge is great, and the inflammatory symptoms have subsided, lime water is useful as an astringent. As an injection in leucorrhœa and gleet it sometimes succeeds where other remedies have failed. The internal use of lime water has also been serviceable in checking secretion from various other parts, as from the bronchial membranes, the bladder, &c.

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[e] *Gentleman's Magazine* for 1740, vol. x. p. 185.

[f] D'Escherny, *A Treatise of the Causes and Symptoms of the Stone*, 1755.

[g] *Gentleman's Magazine* for 1739, vol. ix. p. 298.

[h] Alston's *Lectures on the Materia Medica*, vol. i. p. 268. London, 1770.

[i] Chevallier, *Lond. Med. Gaz.* vol. xx. p. 460.

[j] Van Swieten's *Commentaries upon Boerhaave's Aphorisms*, vol. xvi. p. 299.

[k] *Lond. Med. Gaz.* vol. xx. p. 584.

United States' Dispensatory.

Besides the above, lime water has been employed for various other purposes. Thus, as an antispasmodic, in hypochondriasis and hysteria, with habitual excessive sensibility of the nervous system, it has been found useful by Weickard[m]. It has also been given as an alterative in glandular enlargements and venereal affections, and to promote the deposit of bone earth in diseases accompanied with a deficiency of this substance. In skin diseases (tinea capitis, scabies, prurigo, &c.) it has been applied as a wash.

ADMINISTRATION.—From half an ounce to three or four ounces may be taken three times a day. As already mentioned, it may be conveniently administered in combination with milk.

1. **LIQUOR CALCIS**, L.; *Aqua Calcis*, E. D.; *Lime Water* (Lime, lbss.; Distilled Water, Oxij. Upon the lime, first slaked with a little water, pour the remaining water, and shake them together; then immediately cover the vessel, and set it by for three hours: afterwards, keep the solution, with the remaining lime, in stoppered glass vessels; and, when it is to be used, take from the clear solution.—The *Edinburgh College* uses Lime *one part*, and Water *twenty parts.*—The *Dublin College* employs of fresh-burnt Lime *one part*, and Water *thirty-one parts;* one of which is to be hot, and added just to slake the lime, the other is to be cold, and is added afterwards). Lime water is colourless and transparent; but, by exposure to the air, becomes covered with a film of carbonate of lime, which is deposited on the sides and bottom of the vessel, and is succeeded by another. Hence lime water should be preserved in well-stoppered vessels with some undissolved lime, and, when used, the clear liquor poured off. Its taste is unpleasant and alkaline, and it has an alkaline re-action on vegetable colours. The dose of lime water is from f℥ss. to f℥iij. or f℥iv. three times a day. It may be conveniently administered in milk. Its uses have been above stated.

2. **LINIMENTUM CALCIS**, E. D.; *Liniment of Lime; Carron Oil.*—(Linseed Oil [Olive Oil, *D.*], Lime Water, of each equal measures; Mix and agitate them together). Linseed and olive oils are each composed of oleic and margaric acids and glycerine. When mixed with lime water an oleo-margarate of lime (*calcareous soap*) is formed. It has long been celebrated as an application to burns and scalds, and is employed for this purpose at the Carron Ironworks—hence one of its names. Though the Dublin College orders olive oil, it is almost

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[m] Richter's *Ausf. Arzneim.* iii. 585.

invariably prepared with linseed oil. Turpentine is sometimes advantageously added to it.

2. CAL'CII CHLO'RIDUM, *L.*—CHLORIDE OF CALCIUM.

(Calcis Murias, *E. D.*)

History.—This salt, obtained in the decomposition of sal ammoniac by lime, was known, according to Dulk[n], in the fifteenth century, to the two Hollands, who called it *Fixed Sal Ammoniac (Sal Ammoniacum fixum)*. Its composition was not understood until the eighteenth century, when it was ascertained by Bergman, Kirwan, and Wenzel. It is commonly termed *Muriate of Lime*.

Natural History.—It occurs in both kingdoms of nature.

α. In the Inorganized Kingdom.—It is found, in small quantity, in sea and many mineral and well waters.

β. In the Organized Kingdom.—It has been detected, in a few instances, in vegetables. Thus Pallas recognised it in the root of *Aconitum Lycoctonum.*

Preparation.—The following are the methods of preparing it:

The *London College* orders it to be obtained as follows:—Take of Chalk, ℥v.; Hydrochloric Acid, Distilled Water, of each Oss. Mix the acid with the water, and to these gradually add the chalk to saturation. Then, the effervescence being finished, strain; evaporate the liquor until the salt is dried. Put this into a crucible, and, having melted it in the fire, pour it out upon a flat clean stone. Lastly, when it is cold, break it into small pieces, and keep it in a well-closed vessel.

The *Edinburgh College* orders of White Marble, in fragments, ℥x.; Muriatic Acid (commercial) and Water, of each, Oj. Mix the acid and water; add the marble by degrees; and, when the effervescence is over, add a little marble in fine powder till the liquid no longer reddens litmus. Filter, and concentrate to one-half. Put the remaining fluid in a cold place to crystallize. Preserve the crystals in a well-closed bottle. More crystals will be obtained by concentrating the mother liquor.

Chloride of calcium is a secondary product in the manufacture of the hydrated sesquicarbonate of ammonia (see p. 309), as well as of solution of ammonia (see p. 297); and from this source it is usually procured.

The *Dublin College* orders of the liquor which remains after the distillation of the water of caustic ammonia any requisite quantity. Filter the liquor, and expose it in an open vessel to heat until the muriate of lime becomes perfectly dry. Let it be preserved in a vessel completely closed.

In this process one equivalent or 37 parts of hydrochloric acid react on one equivalent or 50 parts of carbonate of lime, and produce one equivalent or 22 parts of carbonic acid, which escape in a gaseous form, one equivalent or 9 parts of water, and one equivalent or 56 parts of chloride of calcium.

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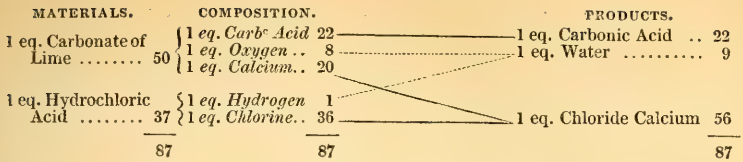
[n] *Die Preuss. Pharm. übersetst.* &c. ii. 293, 2^{te} Aufl. Leipsig, 1830.



By heat the crystals of this salt lose their water, and the anhydrous chloride of calcium is obtained.

PROPERTIES.—Anhydrous chloride of calcium is a white translucent solid, of a crystalline texture. Its taste is bitter and acrid saline. It is fusible, but not volatile. It deliquesces in the air, and becomes what has been called *Oil of Lime* (*Oleum Calcis*). When put into water it evolves heat, and readily dissolves in a quarter of its weight of this fluid at 60° F., or in a much less quantity of hot water. By evaporation the solution yields striated crystals (*Hydrated Chloride of Calcium*), having the form of regular six-sided prisms, and which, therefore, belong to the rhombohedric system. These crystals undergo the watery fusion when heated, are deliquescent, readily dissolve in water with the production of great cold, and, when mixed with ice or snow, form a powerful frigorific mixture. Both anhydrous and hydrous chloride of calcium are readily soluble in alcohol.

Characteristics.—This salt is known to be a chloride by the tests for this class of salts before mentioned (p. 226). The nature of its base is ascertained by the tests for lime (p. 578).

COMPOSITION.—The composition of this salt is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Ure.*
Calcium	1	20	35·71	36·7
Chlorine	1	36	64·28	63·3
Chloride Calcium ..	1	56	99·99	100·0

	Atoms.	*Eq.Wt.*
Chloride Calcium ..	1	56
Water	6	54
Crystalld Chlde Calcm	1	110

PURITY.—Chloride of calcium, when pure, is colourless, evolves no ammonia when mixed with lime, and undergoes no change of colour nor gives any precipitate with caustic ammonia, chloride of barium, or hydrosulphuric acid.

The fused chloride is free from colour; slightly translucent; hard and friable; totally soluble in water: the solution gives no precipitate on the addition of ammonia or chloride of barium, nor, when diluted with much water, with ferrocyanide of potassium. *Ph. Lond.*

The crystallized salt is "extremely deliquescent. A solution of 76 grains in one fluidounce of distilled water, precipitated by 49 grains of oxalate of ammonia, remains precipitable by more of the test." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Three drachms and a half given to a dog caused quick breathing and snorting, with convulsive but vain efforts to vomit, a profuse secretion of saliva, and death in six hours. The mucous membrane of the stomach and small intestines was very blood-shot, and in many places almost black, and converted into a gelatinous mass[o].

β. On Man.—In *small doses* it promotes the secretions of mucus, urine, and perspiration. It operates, therefore, as a liquefacient (see p. 194). By continued use it appears to exercise a specific influence over the lymphatic vessels and glands, the activity of which it increases; for under its use glandular and other swellings and indurations have become smaller and softer, and ultimately disappeared altogether. In *larger doses* it excites nausea, vomiting, and sometimes purging; causes tenderness of the præcordium, quickens the pulse, and occasions faintness, weakness, anxiety, trembling, and giddiness. In *excessive doses* the disorder of the nervous system is manifested by failure and trembling of the limbs, giddiness, small contracted pulse, cold sweats, convulsions, paralysis, insensibility, and death[p]. Considered in reference to other medicines, it has the closest resemblance in its operation to chloride of barium. Hufeland[q] says its operation is more irritant than the last mentioned substance, and that its use requires greater caution,—a statement which is directly opposed to the experience of Dr. Wood[r], and of most other practitioners.

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[o] Beddoes, *Duncan's Annals of Medicine*, vol. i. Lustr. ii. 208.

USES.—It has been principally employed in scrofulous affections, especially those attended with glandular enlargements. Beddoes[s] gave it to nearly a hundred patients, and he tells us there are few of the common forms of scrofula in which he has not had successful experience of it. Dr. Wood[t] tried it on an extensive scale, and with decided benefit. It has been found most efficacious in the treatment of tabes mesenterica, checking purging, diminishing the hectic fever, allaying the inordinate appetite, and, in many cases, ultimately restoring the patient to perfect health. It has also been recommended in chronic arthritic complaints, in bronchocele, in some chronic affections of the brain (as paralysis), and in other cases where the object was to excite the action of the absorbents.

Occasionally, though rarely, it has been employed externally. Thus a bath containing two or three ounces of it, either alone or with chloride of sodium, has been used in scrofula[u].

In pharmacy fused chloride of calcium is used in the rectification of spirit (p. 349), on account of its strong affinity for water; and in chemistry it is employed in the drying of gases. In the crystallized state, mixed with half or two-thirds of its weight of ice or snow, it is used for producing an intense degree of cold. Its solution is used as a salt-water bath for chemical purposes.

ADMINISTRATION.—Chloride of calcium is always used medicinally in the form of aqueous solution.

LIQUOR CALCII CHLORIDI, L.; *Calcis Muriatis Solutio*, E.; *Calcis Muriatis Aqua*, D. (Chloride of Calcium [fused], ℥iv.; Distilled Water, f℥xij. *L.*—Muriate of Lime [crystals], ℥viij; Water, f℥xij. *E.*—

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[p] Vogt, *Pharmakodynamik.*

[q] Quoted by Wibmer, *Die Wirkung*, &c.

[r] *Edinb. Med. and Surg. Journ.* i. 147.

[s] *Op. cit.*

[t] *Op. cit.*

[u] Vogt, *op. supra cit.*

Muriate of Lime [dry], *two parts*; Distilled Water, *seven parts*, D.—Dissolve and [if necessary] strain). Dose from ♏xl. or ♏l. to f℥ij., or gradually increased until nausea is produced. The uses of it have been above noticed.

3. CAL'CIS HYPOCHLO'RIS.—HYPOCHLORITE OF LIME.

(Calx Chlorinata, *L. E.*)

History.—In 1798, Mr. Tennant, of Glasgow, took out a patent for the manufacture of this substance as a bleaching powder, which in consequence was long known as *Tennant's Bleaching Powder*. According to the views entertained of its composition it has been successively termed *Oxymuriate of Lime*, *Chloride of Lime* or *Chloruret of the Oxide of Calcium*, *Chlorite of Lime* (Berzelius), and *Chlorinated Lime*.

Preparation.—Chloride of lime is prepared on a very large scale for the use of bleachers. The *London College*, however, has thought fit to give the following directions for its preparation:—

> Take of Hydrate of Lime, lbj.; Chlorine as much as may be sufficient; pass Chlorine to the Lime, spread in a proper vessel, until it is saturated. Chlorine is very readily evolved from Hydrochloric Acid added to Binoxide of Manganese, with a gentle heat (see p. 225).

On the large scale the gas is generated in large, nearly spherical, leaden vessels heated by steam. The ingredients employed are binoxide of manganese, chloride of sodium, and diluted sulphuric acid. The gas is washed by passing it through water, and is then conveyed by a leaden tube into the combination room, where the slaked lime is placed in shelves or trays, piled over one another to the height of five or six feet, cross bars below each, keeping them about an inch asunder, that the gas may have free room to circulate. The combination room is built of siliceous sandstone, and is furnished with windows, to allow the operator to judge how the impregnation is going on. Four days are usually required, at the ordinary rate of working, for making good marketable chloride of lime[v]. At Mr. Tennant's manufactory at Glasgow, the lime is placed in shallow boxes on the floor of the combination chambers, and is agitated once during the process by iron rakes; the handles of which pass through boxes filled with lime, which serves as a valve[w]. The supply of chlorine is then shut off, and a man enters the chambers and rakes the lime over. The chambers are then closed, and more chlorine introduced, until the lime is saturated.

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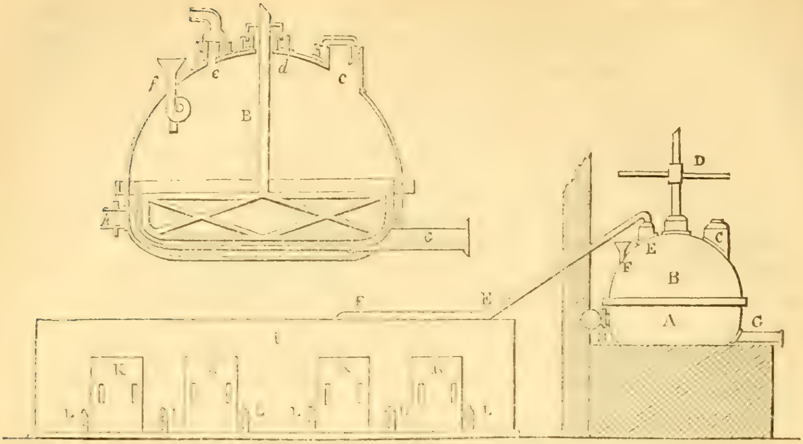
[v] Ure, *Quart. Journ. of Science*, xiii. 1.

[w] *American Journ. of Science*, vol. x. No. 2, Feb. 1826, and Dumas' *Traité de Chimie*, ii. 806.

FIG. 100. FIG. 99.



Apparatus for the Manufacture of Chloride of Lime.

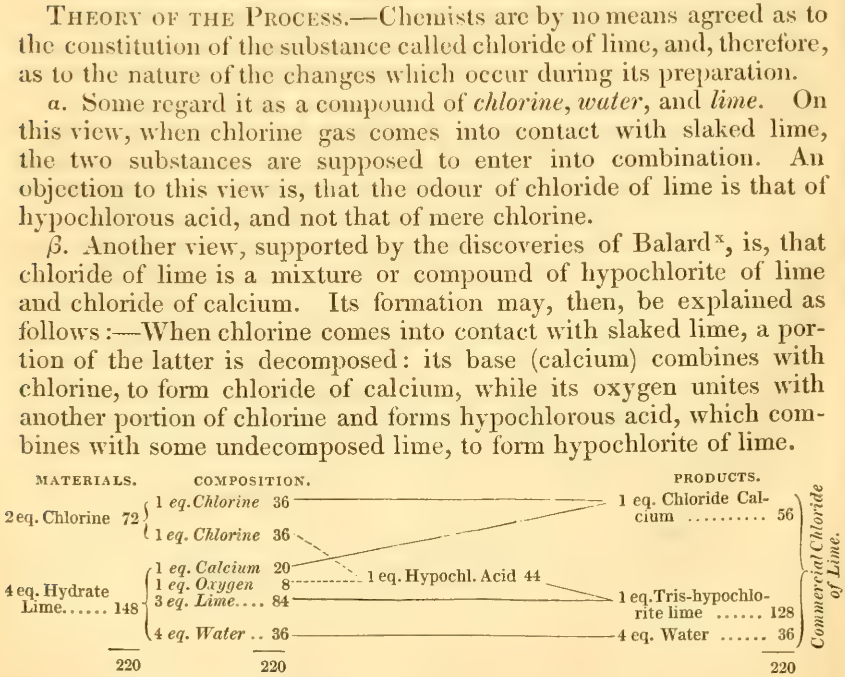
Fig. 99.—A. Iron jacket for heating the retort by steam.
B. Leaden retort for generating chlorine.
C. Aperture for the introduction of manganese and common salt.
D. Arm of the agitator.
E. Gas discharge pipe.
F. Syphon funnel for the introduction of the sulphuric acid.
G. Discharge pipe for drawing off the residuum of the operation.
H. Steam pipe.
I. Combination chamber, divided into four compartments, each having two doors.
K, K. Doors, each having two windows.
L, L. Handles of the rakes passing through boxes.

Fig. 100.—*Section of the Retort.*
B. The agitator. The explanation of the other letters is the same as for fig. 99.

THEORY OF THE PROCESS.—Chemists are by no means agreed as to the constitution of the substance called chloride of lime, and, therefore, as to the nature of the changes which occur during its preparation.

a. Some regard it as a compound of *chlorine*, *water*, and *lime*. On this view, when chlorine gas comes into contact with slaked lime, the two substances are supposed to enter into combination. An objection to this view is, that the odour of chloride of lime is that of hypochlorous acid, and not that of mere chlorine.

β. Another view, supported by the discoveries of Balard[x], is, that chloride of lime is a mixture or compound of hypochlorite of lime and chloride of calcium. Its formation may, then, be explained as follows:—When chlorine comes into contact with slaked lime, a portion of the latter is decomposed: its base (calcium) combines with chlorine, to form chloride of calcium, while its oxygen unites with another portion of chlorine and forms hypochlorous acid, which combines with some undecomposed lime, to form hypochlorite of lime.



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[x] *Researches*, in Taylor's *Scientific Memoirs*, vol. i. p. 269.

The odour of hypochlorous acid which chloride of lime possesses, strongly supports this view. On the other hand it may be objected, that if chloride of lime contained so large a quantity of chloride of calcium, it would be deliquescent. But to this it may be replied, that the chloride of calcium may be in chemical combination with the hypochlorite of lime.

γ. More recently, Millon[y] has discovered some new facts which he asserts are inexplicable on the view just explained; and he suggests that chloride of lime is a substance analogous to peroxide of calcium, but in which one equivalent of the oxygen of the peroxide is replaced by an equivalent of chlorine. His view, which Professor Graham[z] regards as "simpler" than the preceding, is supported by the fact that many of the precipitates formed in metallic solutions by a solution of chloride of lime, are composed of one equivalent of the metallic oxide and one equivalent of chlorine.

Properties.—Chloride of lime, as met with in commerce, is a white or brownish white powder, having a feeble odour of hypochlorous acid, and a strong bitter and acrid taste. Exposed to the air it attracts carbonic acid, evolves chlorine, and is thereby converted into a mixture of carbonate of lime and chloride of calcium, the latter of which deliquesces. Digested in water the chloride or hypochlorite of lime dissolves, as well as any chloride of calcium present, and a small portion of caustic lime: any carbonate and the excess of caustic lime remain undissolved. The solution, which has a slight yellow colour, first reacts on vegetable colours as an alkali, and afterwards bleaches them, especially if an acid be added. Its bleaching and disinfecting properties depend either on the oxidizement or on the dehydrogenization of the colouring or infectious matter: if an acid be employed in the process, chlorine is evolved, which produces oxygen at the expense of the elements of water: if, on the contrary, no acid be used, Balard[a] supposes that both the hypochlorous acid and lime give out their oxygen, and thereby become chloride of calcium. When chloride of lime is heated it evolves first chlorine and subsequently oxygen.

Characteristics. — Its smell and bleaching properties are most characteristic of it. The acids (as sulphuric or hydrochloric) separate chlorine from it. An aqueous solution of it throws down white precipitates with nitrate of silver, the alkaline carbonates, and with oxalic acid or the oxalates. The supernatant liquor from which chloride of silver has been thrown down by nitrate of silver possesses a decolorizing property.

Composition.—The quantity of chlorine absorbed by slaked lime varies with the pressure, the degree of exposure, and the quantity of water present. Hence the substance sold as chloride of lime is not an uniform product. Moreover, it would appear from Dr. Ure's experiments, not to have any definite atomic constitution. The following table contains the most important results of his experiments:—

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[y] *Journal de Pharmacie*, t. xxv. p. 595. 1839.

[z] *Elements of Chemistry*, vol. i. p. 501.

[a] *Researches*, in Taylor's *Scientific Memoirs*, vol. i. p. 269.

Prepared with Protohydrate of Lime, without pneumatic pressure. The process was carried on until the Lime ceased to absorb Chlorine.					Commercial Specimens.		
	Synthesis.	1st *Analysis.*	2nd *Analysis.*	*Mean.*	1.	2.	3.
Chlorine......	39·39	40·00	40·62	40·31	23	22	28
Lime	46·00	44·74	46·07	45·40	46	78	71
Water........	14·60	15·26	13·31	14·28	31		
Chlore of Lime	100·00	100·00	100·00	100·00	100	100	100

Mr. Brande[b] and Mr. Phillips[c] give the following as the atomic proportions of chlorine, lime, and water, in chloride of lime of the best quality:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Chlorine..........	1	36	32·73
Lime	2	56	50·91
Water	2	18	16·36
Chloride of Lime..	1	110	100·00

Constitution, according to Mr. Phillips.	*Atoms.*	*Eq.Wt.*
Bihydrated Chloride of Lime	1	82
Lime	1	28
	1	110

"When water is added to this, the chloride of lime dissolves, leaving nearly all the lime insoluble." (Phillips.)

If, with Berzelius and Balard, we regard bleaching powder as constituted of hypochlorite of lime, chloride of calcium, and water, its composition, corresponding with the proportions assumed by Mr. Brande and Mr. Phillips, will be as follows:

	Atoms.	*Eq. Wt.*	*Per Ct.*
Trishypochlorite of Lime........	1	128	58·18
Chloride Calcium	1	56	25·45
Water........................	4	36	16·36
Chloride of Lime................	1	220	99·99

When bleaching powder is digested in water, a bleaching liquor is obtained, while a portion of lime remains undissolved. The trishypochlorite is supposed to be decomposed by the action of water; and to deposit two equivalents of lime, while one equivalent of chloride of calcium, and one equivalent of neutral hypochlorite of lime are dissolved.

CHLOROMETRY.—In order to estimate the bleaching power of the chloride of lime of commerce, various chlorometrical methods have been devised. One method is to determine the quantity of chlorine gas which is given out by a certain weight of chloride on the addition of liquid hydrochloric acid[d]. The liquid may be brought into con-

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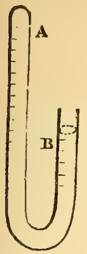
[b] *Manual of Chemistry*, 5th ed. p. 676. "Upon the whole," says Mr. Brande, "it is not improbable that bleaching powder consists of a chloride of lime, containing one proportional of chlorine and one of lime, mixed with a varying proportion of hydrate of lime."

[c] *Translation of the Pharmacopœia*, 4th ed. p. 234.

[d] Ure, *Quarterly Journal of Science*, vol. xiii.

Fig. 101.



Syphon-tube for chlorometrical purposes.

tact with the chloride placed over mercury, contained in a graduated syphon-tube, closed at one end, (Fig. 101, A). When the gas is evolved, the mercury flows out, by the orifice B, into a basin ready to receive it. The resulting film of chloride of calcium protects the surface of the metal from the action of the chlorine. If carbonic acid be suspected, the mercury by agitation absorbs the chlorine, leaving the carbonic acid. Ten grains of bleaching powder yield from three to four cubic inches of chlorine, equivalent to twenty or thirty per cent. by weight.

Another chlorometrical method is to ascertain the bleaching power of the chloride on a standard solution of indigo [e]; but it is not susceptible of accuracy.

A chlorometrical method, which Professor Graham [f] considers "to be entitled to preference," is founded on the fact, that chloride of lime converts sulphate of the protoxide of iron into sulphate of the peroxide. Red ferroprussiate of potash (*ferrosesquicyanide of potassium*) is employed to ascertain the change in the degree of the oxidation of the iron, since it gives a blue precipitate with the protosalts, but not with the persalts, of this metal. A quantity of solution of chloride of lime capable of peroxidising 78 grains of sulphate of iron, contains 10 grains of chlorine.

The *Edinburgh College* gives the following characteristics of good chloride of lime:—

> "Pale grayish-white: dry: 50 grains are nearly all soluble in two fluidounces of water, forming a solution of the density 1027, and of which 100 measures, treated with an excess of oxalic acid, give off much chlorine, and if then boiled and allowed to rest twenty-four hours, yield a precipitate which occupies nineteen measures of the liquid."

The precipitate produced in the solution by oxalic acid is oxalate of lime, and, therefore, this process is one for the detection of lime (or calcium).

The *London College* merely observes that chlorinated lime—

> "Dissolves in dilute hydrochloric acid, emitting chlorine."

Neither College, therefore, gives directions for estimating the real value of chloride of lime.

Physiological Effects.—The local action of chloride of lime is that of an irritant and caustic. A solution of it applied to suppurating and mucous surfaces is a powerful desiccant, probably in part at least from the uncombined lime in solution. When the secretions are excessive and extremely fetid, it not only diminishes their quantity, but much improves their quality; so that, considered in reference to suppurating and mucous surfaces, it is not only a desiccant, but, in morbid conditions of these parts, a promoter of healthy action. Applied in the form of ointment (composed of a drachm of chloride to an ounce of fatty matter) to scrofulous swellings, Cima[g] found that it provoked suppuration, caused strong redness, promoted the suppurating process, and dispersed the surrounding hardness.

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[e] Gay-Lussac, *Ann. of Phil.* xxiv. 218; also in Alcock's *Essay*, before quoted, p. 135.
[f] *Elements of Chemistry*, p. 502.

Taken internally, in *small doses* (as from 3 to 6 grains, dissolved in one or two ounces of water), it sometimes causes pain and heat in the stomach, and occasionally, according to Cima, purging. Under the continued use of it, hard and enlarged absorbent glands have become softer and smaller, from which circumstance it has been supposed to exercise a specific influence over, and to promote the healthy action of, the lymphatic system. During its employment, Cima says he did not find it necessary to give purgatives. Dr. Reid[h] gave it in the epidemic fever, which raged in Ireland in 1826, and he tells us that it rendered the tongue cleaner, abated the delirium, and promoted the cutaneous functions. In dysentery it soon put a stop to the bloody evacuations, the umbilical pain, and the tenesmus.

I am not acquainted with any facts respecting the effects of chloride of lime *in large or poisonous doses*. Analogy would lead us to expect that it would produce the combined effects of a caustic and of an agent specifically affecting the nervous system.

USES.—The chlorides (hypochlorites) of lime and soda are extensively employed as disinfectants and antiseptics. I have already stated (p. 228) that chlorine gas stands unrivalled for its power of destroying putrid odours and checking putrefaction, and where uninhabited chambers or buildings are to be purified, fumigations with this gas should be adopted. But its powerful action on the organs of respiration precludes its use in inhabited places; and, in such cases, the alkaline chlorides (chloride of lime, on account of its cheapness) are to be substituted. When these substances are in contact with organic matter, it is supposed the hypochlorite gives out oxygen, and is converted into a metallic chloride; the oxygen being the effective disinfecting and antiseptic agent; or it may act by abstracting hydrogen. When, however, the solution of the chloride (hypochlorite) is exposed to the air, carbonic acid is attracted by the lime, and hypochlorous acid set free, which immediately reacts on any organic matter present. Hence these chlorides (hypochlorites), when exposed to the air, evolve chlorine so slowly, and in such moderate quantities, as not to produce any noxious effects, though their action on organic matters is very powerful. Their most obvious effect is that of destroying the unpleasant odour of putrid matter. Their action on hydrosulphuric acid, ammonia, and hydrosulphate of ammonia (substances evolved by decomposing animal matters) can be readily and easily demonstrated. Other odorous principles given out by putrid matters are, by the experience of most persons, admitted to be destroyed by the alkaline chlorides, though Piorry[i] has asserted, they are only overpowered by the stronger smell of the chlorine.

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[g] Configliachi and Brugnatelli's *Giornale di Fisica*, 1825; quoted by Dierbach, *d. neust. Entd. in d. Mat. Méd.* 1828, 2te Abt. 597.

[h] *Trans of the Associat. of Fellows and Licentiates of the College of Physicians in Ireland*, vol. v. 1828.

The alkaline chlorides (hypochlorites) possess another valuable property—that of stopping or checking the putrefactive process; and hence they are called antiseptics[j].

These two properties, viz. that of destroying offensive odours and that of preventing putrefaction, render the alkaline chlorides most valuable agents to the medical practitioner. We apply them to gangrenous parts, to ulcers of all kinds attended with foul secretions, to compound fractures accompanied with offensive discharges, to the uterus in various diseases of this viscus attended with fetid evacuations: in a word, we apply them in all cases accompanied with offensive and fetid odours. As I have before remarked, with respect to chloride of soda (p. 541), their efficacy is not confined to an action on dead parts, or on the discharges from wounds and ulcers; they are of the greatest benefit to living parts, in which they induce more healthy action, and the consequent secretion of less offensive matters. Furthermore, in the sick chamber, many other occasions present themselves on which the power of the chlorides to destroy offensive odours will be found of the highest value: as, to counteract the unpleasant smell of dressings or bandages, of the urine in various diseases of the bladder, of the alvine evacuations, &c. In typhus fever a handkerchief, or piece of calico, dipped in a weak solution of an alkaline chloride, and suspended in the sick chamber, will be often of considerable service both to the patient and the attendants.

The power of the chlorides (hypochlorites) to destroy infection or contagion, and to prevent the propagation of epidemic diseases, is less obviously and satisfactorily ascertained than their capability of destroying odour. Various statements have been made by Labarraque, and others[k], in order to prove the disinfecting power of the chlorides with respect to typhus and other infectious fevers. But, without denying the utility of these agents in destroying bad smells in the sick chamber, and in promoting the recovery of the patient, by their influence over the general system, I may observe that I have met with no facts which are satisfactory to my mind as to the chemical powers of the chlorides to destroy the infectious matter of fever. Nor am I convinced by the experiments made by Pariset and his colleagues[l], that these medicines are preservative against the plague. Six individuals clothed themselves with impunity in the garments of men who had died of plague, but which garments had been plunged for six hours in a solution of chloride of soda. But, as Bouillaud[m] has truly observed, the experiments, to be decisive, should have been made with clothing which had already communicated the plague to the wearers of it. In Moscow, chlorine was extensively tried and found unavailing, nay, apparently injurious, in cholera. "At the time," says Dr. Albers[n], "that the cholera hospital was filled with clouds of chlorine, then it was that the greatest number of he attendants were attacked[o]." Some years ago chlorine was tried at the Small Pox Hospital, with a view of arresting the progress of erysipelas: all offensive smell, as usual, was overcome, but the power of communicating the disease remained behind[p]. Bousquet[q] mixed equal parts of a solution of chloride of soda and the vaccine lymph, and found that the latter still possessed the power of producing the usual cow-pock vesicle. These are a few of the facts which are adverse to the opinion that chlorine or the alkaline chlorides possess the power of preventing the propagation of infectious, contagious, or epidemic diseases. In opposition to them there are but few positive facts to be adduced. Coster[r] found that a solution of chloride of soda destroyed the infectious properties of the syphilitic poison, and of the poison of rabid animals. The statements of Labarraque[s] and others as to the preservative powers of the chlorides in typhus, measles, &c. are too loose and general to enable us to attach much value to them.

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[i] *Journ. Chim. Méd.* ii. 601.

[j] For various facts in proof of this, I must refer to the late Mr. Alcock's *Essay on the Use of the Chlorurets.* Lond. 1827.

[k] Vide Alcock's *Essay,* p. 155, *et seq.*

[l] *Bullet. des Sciences Méd.* xix. 233.

[m] *Dict. de Méd. Prat.,* art. *Contagion.*

Considered in reference to medical police, the power of the alkaline chlorides (hypochlorites) to destroy putrid odours and prevent putrefaction is of vast importance. Thus chloride of lime may be employed to prevent the putrefaction of corpses previously to interment, to destroy the odour of exhumed bodies during medico-legal investigations, to destroy bad smells, and prevent putrefaction in dissecting-rooms and worshops in which animal substances are employed (as cat-gut manufactories), to destroy the unpleasant odour from privies, sewers, drains, wells, docks, &c., to disinfect ships, hospitals, prisons, stables, &c. The various modes of applying it will readily suggest themselves. For disinfecting corpses, a sheet should be soaked in a pailful of water containing a pound of chloride, and then wrapped around the body. For destroying the smell of dissecting-rooms, &c. a solution of the chloride may be applied by means of a garden watering-pot. When it is considered desirable to cause the rapid evolution of chlorine gas, hydrochloric acid may be added to chloride of lime.

Chloride of lime (or chloride of soda) is the best *antidote* in poisoning by hydrosulphuric acid, hydrosulphuret of ammonia, sulphuret of potassium, and hydrocyanic acid. It decomposes and renders them inert. A solution should be administered by the stomach, and a sponge or handkerchief soaked in the solution, held near the nose, so that the vapour may be inspired. It was by breathing air impregnated with the vapour arising from chloride of lime, that the late Mr. Roberts (the inventor of the miner's improved safety lamp,) was enabled to enter and traverse with safety the sewer of the Bastile, which had not been cleansed for 37 years, and which was impregnated with hydrosulphuric acid[r]. If a person be required to enter a place suspected of containing hydrosulphuric acid, a handkerchief moistened with a solution of chloride of lime should be applied to the mouth and nostrils, so that the inspired air may be purified before it passes into the lungs.

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[n] *Lond. Med. Gaz.* viii. 410.

[o] See also Dierbach, *Die neust. Entd. in d. Mat. Med.* i. 411, 2te Ausg. 1837.

[p] *Lond. Med. Gaz.* viii. 472.

[q] *Rev. Med.* Fev. 1830, p. 264.

[r] Richter, *Ausf. Arzneimittell.* Suppl. Band. 539.

[s] Alcock's *Essay*, pp. 56, 58, &c.

A solution of chloride of lime has been used as a wash in some skin diseases. Derheims[s] used a strong solution with great success in scabies. This mode of curing itch is much cleaner and more agreeable than the ordinary method by sulphur frictions. It has likewise been found successful by Fantonetti[t] in tinea capitis: where the discharge is copious, washes of the chloride may be used with advantage. In burns and scalds, Lisfranc employed lotions of chloride of lime either immediately after the accident, or subsequent to the application of emollient poultices.

Solutions of chloride of lime have been employed with great benefit in ophthalmia. Dr. Varlez, surgeon to the military hospital at Brussels[u], states that in 400 cases it never disappointed him once. Mr. Guthrie has also reported favourably of it in three cases; as have likewise MM. Colson, Delatte, and Raynaud. The solution used by Dr. Varlez was composed of from a scruple to three or four drachms of chloride, and an ounce of water. It was dropped into the eye or injected by a syringe, or applied by means of a camel's hair pencil. Of course other means (bleeding, purging, cold, and, in chronic cases, blisters) should be conjoined. I have found a weak solution of the chloride very successful in the purulent ophthalmia of infants. Gubian[v] proposed to apply a solution of chloride of lime to prevent the pitting from small-pox. The fully maturated pustules are to be opened and washed with a weak solution of this salt: desiccation takes place very promptly, and no marks or pits are said to be left behind.

Chloride of lime may be employed *internally* in the same cases that chloride of soda is administered (p. 540). It has been used with great success by Dr. Reid[w] in the epidemic fever of Ireland. In some of the very worst cases it acted most beneficially, causing warm perspiration, rendering the tongue cleaner and moister, checking diarrhœa, and inducing quiet sleep. I also can bear testimony to the good effects of it in bad cases of fever. In disease of the pulmonary organs resulting from febrile excitement, Dr. Reid also found it advantageous. In dysentery likewise it was most valuable. He used it by the mouth, and also in the form of clyster. It corrected the intolerable stench of the evacuations, and improved their appearance. Cima[x] used it both internally and externally in scrofula.

ADMINISTRATION.—*Internally*, chloride of lime may be given in doses of from one grain to five or six grains, dissolved in one or two ounces of water, sweetened with syrup. As the dry chloride of the shops deposits hydrate of lime when put into water, the solution (of the hypochlorite of lime and chloride of calcium) should be filtered, to get rid of this. To destroy the unpleasant smell of the breath, and to restore the white colour of the teeth when stained by tobacco, &c. *tooth-powders* (see p. 219) and *lozenges*[y] containing chloride of lime have been used. An *ointment* (composed of ʒj. of chloride to ℥j. of lard or butter) has been employed, by way of friction, to reduce scrofulous enlargements of the lymphatic glands, when the use of mercurial ointment has failed.

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[r] Alcock's *Essay*.
[s] *Journ. de Chim. Méd.* iii. 575
Ibid. ix. 305.
[u] *Med. and Phys. Journ.* Nov. 1827.
[v] *Journ. de Chim. Med.* vi. 315.
[w] *Trans. of the King and Queen's College of Physicians in Ireland*, v. 266.
[x] Richter. *Ausf. Arzneimitt.* iv. 305.

ANTIDOTES.—Administer albuminous liquids (as eggs beat up with water) or milk, or flour and water, or oil, or mucilaginous drinks, and excite vomiting; combat the gastro-enteritis by the usual means. Carefully avoid the use of acids, which would cause the evolution of chlorine gas in the stomach.

LIQUOR CALCIS CHLORINATÆ; *Solution of Chlorinated Lime; Solution of Chloride of Lime.* A solution of chloride of lime is used for *lotions* and *gargles.* Its strength must vary according to the quality of the chloride and the nature and seat of the disease for which it is employed. The average proportions are from ʒj. to ʒiv. of chloride, and Oj. of water. In the cure of itch, Derheims employed a wash composed of ʒiij. of chloride and Oj. of water. The changes produced in the chloride by the action of water have been already explained (see p. 588). The solution should be filtered to get rid of the hydrate of lime. A solution containing from ten to fifteen grains of the chloride is useful as an *enema* when the alvine evacuations are very offensive. A formula for a disinfecting *mouth-wash* has been already given (see p. 219).

4. CAL′CIS CAR′BONAS.—CARBONATE OF LIME.

(1. Creta, *L. E. D.*—2. Marmor, *L. E. D.*—3. Testæ præparatæ, *L.*)

HISTORY.—Some varieties of carbonate of lime were distinguished and employed in the most remote periods of antiquity. Marble was probably used for building 1050 years berore Christ[z]. Pliny[a] tells us that Dipœnus and Scyllis were renowned as statuaries of marble in the 50th Olympiad (*i. e.* 557 years before Christ). The *Creta*, mentioned by Horace[b] and Pliny was probably identical with our chalk[c].

NATURAL HISTORY.—Carbonate of lime occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—It forms a considerable portion of the known crust of the earth, and occurs in rocks of various ages. It is found in the inferior stratified rocks, but more abundantly in the different groups of the fossiliferous rocks, particularly towards the central and higher parts of the series[d].

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[y] *Journ. de Chim. Méd.* t. iii. p. 496.

[z] 1 *Chron.* xxix. 2.

[a] *Hist. Nat.* xxxvi.

[b] *Sat.* iii. lib. 2.

[c] On the chalk of the ancients, consult Beckmann's *History of Invent.* i. 212.

In the crystallized form it constitutes *Calcareous Spar* and *Arragonite.* The first of these is most extensively distributed, and presents itself under many hundred varieties of shapes[e].

Granular carbonate of lime (the *Granular Limestone* of mineralogists) more commonly occurs in beds, but sometimes constitutes entire mountains. The whitest and most esteemed primitive limestone is that called *Statuary Marble*, or, from its resemblance to white sugar, *Saccharoid Carbonate of Lime.* That from Carrara, on the eastern coast of the Gulf of Genoa, is the kind usually employed by the statuary, and being very pure, should be employed for pharmaceutical purposes: it is the *Marmor* of the British pharmacopœias.

Chalk constitutes the newest of the secondary rocks, and occurs abundantly in the southern parts of England. It lies in beds, and contains abundance of marine as well as terrestrial organic remains. The upper part of a considerable portion of the chalk of England contains numerous flints, which are supposed to have once belonged to poriferous animals[ee].

There are various other native forms of carbonate of lime constituting the substances called by the mineralogists *Schiefer Spar*, *Rock Milk*, *Earth Foam*, *Stalactitic Carbonate of Lime*, *Anthraconite*, *Oolite*, *Pisolite*, *Marl*, *Tufa*, &c.

Carbonate of lime is an ordinary ingredient in mineral and common waters, being held in solution by carbonic acid, and, therefore, deposited when this is expelled by boiling or otherwise.

β. IN THE ORGANISED KINGDOM.—Carbonate of lime is found in some plants, and is obtained from the ashes of most. It is an abundant constituent of animals, especially of the lower classes. Thus in the Radiate animals we find it in the hard parts of Corals, Madrepores, &c.; in the Molluscs (as the Oyster), it is in the shells. In the articulated animals it forms, with phosphate of lime, the crusts which envelop these animals (as the Crab and Lobster); in the higher classes it is found in bone, but the quantity of it is very small.

PREPARATION.—Several forms of carbonate of lime are employed in medicine; viz. Marble, Chalk, Precipitated Carbonate of Lime, and Carbonate of Lime from Animals. Most of these require to be submitted to some preparation before they are fitted for use.

1. Marble; *Marmor. Carbonas Calcis* (*durus*), L. *Massive Crystalline Carbonate of Lime: White Marble*, E. *Marmor album*, D.—This is employed for the preparation of carbonic acid (p. 333) and for other purposes. White or statuary marble from Carrara should be selected on account of its freedom from iron. It requires no preparation.

2. Chalk; *Creta. Calcis Carbonas (friabilis)*, L.—*Creta. Friable Carbonate of Lime: Chalk*, E.—*Creta alba*, D.—This is found in great abundance in the southern parts of England. It is ground in a mill, and the finer particles separated by washing them over in water, letting the water settle, and making up the sediment into flat cakes, which are dried in this air. In this state it is called *Whiting.* All the British Colleges give directions for the preparation of chalk by elutriation. By this means it is separated from siliceous and ferruginous particles. The product is called *Prepared Chalk* (*Creta Præparata*, L. E. D.) It is usually made up into little conical loaves.

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[d] De la Beche, *Researches in Theoretical Geology*, 21.

[e] See Bournon's *Traité Complet de la Chaux Carbonatée.* Londres, 1808.

[ee] Dr. Grant, *Lect. on Comp. Anat.* in the *Lancet*, Nov. 2, 1833.

The *London College* orders of Chalk, lbj.; Water as much as may be sufficient; add a little Water to the Chalk, and rub it that it may become fine powder. Put this in a large vessel with the rest of the Water; then stir it, and after a short interval pour off the supernatant water, still turbid, into another vessel, and set it by that the powder may subside; lastly, the Water being poured off, dry this powder and keep it for use. In the same way shells, first freed from impurities and washed with boiling water, are prepared.

The directions of the *Edinburgh* and *Dublin Colleges* are essentially the same, except that no mention is made of the preparation of chalk from shells.

3. Precipitated Carbonate of Lime. (*Calcis Carbonas præcipitatum*, D.)—Carbonate of lime prepared by precipitation is employed by some druggists in the preparation of *Aromatic Confection.* It is also preferred to the ordinary prepared chalk for making *Camphorated Cretaceous Tooth-powder.* The Dublin College directs it to be employed in the preparation of the *Hydrargyrum cum Cretâ*, D. The following is the mode of preparing it:—

Take of Solution of Muriate of Lime, *five parts;* add of Carbonate of Soda dissolved in four times its weight of distilled water, three parts. Let the precipitate be mixed with water, and suffered to subside, and let this operation be three times repeated with a sufficiently large quantity of water: lastly, when collected, let the powder be dried on a chalk stone or on paper. *Ph. Dub.*

It should be prepared with cold solutions, otherwise the deposit is finely granular.

4. Carbonate of Lime from Animals.—Carbonate of lime is obtained from various animal substances; as from Oyster shells, Crab's claws, Crab's stones, and Red Coral. These substances yield carbonate of lime intimately blended with animal matter.

α. PREPARED OYSTER SHELLS; *Testæ præparatæ*, L.—See *Ostrea edulis.*

β. PREPARED CRAB'S CLAWS; *Lapilli Cancrorum præparati; Chelæ Cancrorum præparatæ.*—See *Cancer Pagurus.*

γ. PREPARED CRAB'S STONES; *Lapides Cancrorum præparati; Prepared Crab's Eyes; Oculi Cancrorum præparati.*—See *Astacus fluviatilis.*

δ. PREPARED RED CORAL; *Corallium rubrum præparatum.* See *Corallium rubrum.*

PROPERTIES.—Pure carbonate of lime is a tasteless, odourless solid. When heated to redness in a current of air its carbonic acid is expelled, leaving quicklime. It is almost insoluble in water; one part of carbonate requiring 1600 parts of water to dissolve it. It is much more soluble in carbonic acid water: the solution reddens litmus, but changes the yellow colour of turmeric paper to brown; and by boiling, or exposure to the air, gives out its carbonic acid, by which the carbonate of lime is deposited.

Carbonate of lime is a dimorphous substance; that is, it crystallizes in two distinct and incompatible series of forms. Thus the forms of *Calcareous Spar* belong to the rhombohedric system, while *Arragonite* belongs to the right rectangular prismatic system. According to Gustav Rose[f], both calcareous spar and arragonite may be formed in the humid way, but the first at a lower, the latter at a higher, temperature[g]: in the dry way, calcareous spar alone is formed. Both minerals doubly refract the rays of light, and expand unequally in their different parts when heated; but calcareous spar has only one axis of no double refraction (see p. 163, figs. 29 and 30), whereas arragonite has two.

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[f] *Lond. and Edinb. Phil. Mag.* June 1838.

Granular limestone (of which *white marble* is the purest kind) is massive, and consists of small grains of minute crystals, presenting a lamellar structure and brilliant lustre, but intersecting each other in every direction, and thereby giving a glimmering lustre to the mass.

Chalk is massive, opaque when pure white, and has an earthy fracture. It is usually soft to the touch, and adheres to the tongue.

Characteristics.—Carbonate of lime is recognized as a carbonate by the tests already mentioned for this class of salts (p. 334). As a calcareous salt it is known by the characters before described (p. 578) for lime.

COMPOSITION.—Carbonate of lime has the following composition:—

	Atoms.	*Eq Wt.*	*Per Cent.*	*Marcet.*	*Stromeyer.*	*Berzelius.* *Ure.*
Lime	1	28	56	56·1	56·35	56·4
Carbonic Acid	1	22	44	43·9	43·65	43·6
Carbonate of Lime	1	50	100	100·0	100·00	100·0

PURITY.—Pure marble or chalk should be perfectly soluble, with effervescence, in hydrochloric acid, by which the absence of silica is shown. Ammonia should not cause any precipitate with this solution, by which its freedom from alumina, oxide of iron, &c. may be inferred: nor should a solution of sulphate of lime throw down any thing by which the absence of baryta and strontian is proved.

Totally soluble in hydrochloric acid, with effervescence. From this solution, after it has been boiled, when ammonia is dropped in, it throws down nothing. *Ph. Lond.*

"A solution of 25 grains in ten fluidrachms of pyroligneous acid[h], when neutralized by carbonate of soda, and precipitated by 32 grains of oxalate of ammonia, continues precipitable after filtration by more of the test." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The local effects of chalk are those of an absorbent, antacid, and mild *desiccant* (see p. 215). When swallowed it neutralizes the free acid of the gastric juice, and in this way alone must, by continued use, injure the digestive functions. It causes constipation, an effect commonly observed from the use of a few doses in diarrhœa. By the action of the free acids (acetic and hydrochloric) of the alimentary canal, it is converted into two soluble calcareous salts (acetate of lime and chloride of calcium), which become absorbed. Hence the continued use of carbonate of lime is attended with the constitutional effects of the calcareous salts, and consequently the statements which have been made as to the influence of chalk over the lymphatic vessels and glands, and its effect in diminishing excessive secretion, may be correct. Sundelin[i] thinks it may even promote the deposit of bone-earth in diseases attended with a deficiency of this substance. Carbonate of lime, prepared from animal matter, has been erroneously supposed to be more digestible than chalk, and, therefore, less likely to occasion dyspeptic symptoms[j]. Dr. A. T. Thomson[k] says, that "after chalk has been used for some time, the bowels should be cleared out, as it is apt to form into hard balls, and to lodge in the folds of the intestines."

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[g] Colonel Yorke states that the deposit made by water on the interior of a copper boiler is artificial arragonite (*Proceedings of the Chemical Society*, No. 1.)

[h] This quantity of acid is unnecessarily large. According to Mr. Phillips (*Lond. Med. Gaz.* N. S. vol. ii. 1838-9, p. 759), it is capable of dissolving more than four times the above quantity of chalk.

USES. — As an *absorbent* and *desiccant*, prepared chalk is used as a dusting powder in moist excoriations, ulcers, the intertrigo of children, burns and scalds, erysipelatous inflammation, &c. In the form of ointment it has been recommended by Mr. Spender[l] in ulcers.

As an *antacid* it is exhibited in those forms of dyspepsia accompanied with excessive secretion of acid; and as an antidote in poisoning by the mineral and oxalic acids.

It has also been used in some diseases which have been supposed to depend on, or be accompained by, excess of acid in the system—as in gouty affections, which are usually attended with the excessive production of uric acid, and in rachitis, which some have ascribed to a preponderance of phosphoric acid, or to a deficiency of lime in the system.

To diminish alvine evacuations, it is employed in diarrhœa. Its efficacy can hardly be referred solely to its antacid properties, for other antacids are not equally successful; but to its desiccating properties already referred to. Moreover, in many cases of diarrhœa in which chalk is serviceable, no excess of acidity can be shown to exist in the bowels. Aromatics are useful adjuncts to chalk in most cases of diarrhœa. In old obstinate cases, astringents (as catechu or kino) may be conjoined with great advantage; and in severe cases, accompanied with griping pains, opium.

ADMINISTRATION.—Prepared chalk is given in the form of powder or mixture, in doses of from ten grains to one or two drachms. It enters into a considerable number of officinal preparations.

1. MISTURA CRETÆ, L. E. D.; *Chalk Mixture; Cretaceous Mixture.* (Prepared Chalk, ℥ss.; Sugar, ʒiij.; Mixture of Acacia, f℥iss.; Common Water, f℥xviij. Mix. *L.* — Prepared Chalk, ʒx.; Pure Sugar, ʒv.; Mucilage, f℥iij.; Spirit of Cinnamon, ℥ij.; Water, Oij. Triturate the chalk, sugar, and mucilage together; and then add gradually the water and spirit of cinnamon, *E.*—Prepared Chalk, ℥ss.; Refined Sugar, ʒiij.; Mucilage of Gum Arabic, ℥j.; Water, Oj.

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[i] *Heilmittellehre*, i. 179.

[j] Wibmer, *Die Wirkung*, &c. ii. 10.

[k] *Elements of Materia Medica*, ii. 82.

[l] *Observations on Ulcers.*

[*wine measure*]. Mix. *D.*)—A convenient and agreeable form for the exhibition of chalk. It is in very common use for diarrhœa. Aromatics (as *aromatic confection*), astringents (as *kino* or *catechu*), and narcotics (*opium*), are frequently combined with it. Dose, f℥ss. to f℥ij.

2. **PULVIS CRETÆ COMPOSITUS,** L. E. D. *Compound Powder of Chalk.* (Prepared Chalk, lbss.; Cinnamon, ℥iv.; Tormentil Root; Acacia Gum, of each, iij.; Long Pepper, ℥ss. *L. D.* — Prepared Chalk, ℥iv.; Cinnamon, in fine powder, ʒiss.; Nutmeg, in fine powder, ʒj. Triturate them well together.)—Aromatic and astringent. Used in diarrhœa. Dose, grs. x. to ℈j.

3. **TROCHISCI CRETÆ,** E. *Chalk Lozenges.* (Prepared Chalk, ℥iv.; Gum Arabic, ℥j.; Nutmeg, ʒj. Pure Sugar, ℥vj. Reduce them to powder, and beat them with a little water into a proper mass for making lozenges).—Mildly antacid and astringent. Used in acidity of stomach and diarrhœa.

4. **CAMPHORATED CRETACEOUS TOOTH-POWDER.** (Precipitated Carbonate of Lime, *three parts;* Camphor, finely pulverized, *one part.* Mix.)—Extensively used as a dentifrice (see p. 219).

5. CAL'CIS SUBPHOS'PHAS.—SUBPHOSPHATE OF LIME.

HISTORY.—In 1769 Scheele discovered that bones contained an earthy salt composed of phosphoric acid and lime. As these two substances combine together in several proportions to form phosphates, chemists distinguish the combination found in bones by the name of the *Bone Phosphate*, or the *Subphosphate of Lime.*

NATURAL HISTORY.—Subphosphate of lime constitutes the principal part of the earthy matter of the bones of the *Vertebrata* and of the crustaceous envelopes of the *Articulata.* According to Dr. Wollaston[m] the same subphosphate is found in the ossification of the arteries, veins, valves of the heart, bronchiæ, and tendinous portion of the diaphragm. Moreover, the tartar of the teeth is composed of it.

The calcareous phosphate found in urine, and which is sometimes deposited from this fluid in a pulverulent form, is the neutral phosphate of lime ($CaO + PO^{2\frac{1}{2}}$). The phosphate of lime calculus, prostatic calculi, and pineal concretion, also contain, according to Dr. Wollaston, the neutral phosphate. The same salt is held in solution by carbonic acid in some mineral waters[n]. The calcareous phosphate found crystallized in some plants is probably the neutral phosphate.

The mineral called *Apatite* is the subsesquiphosphate of lime ($^{3}CaO + 2PO^{2\frac{1}{2}}$).

PREPARATION.—When bones are ignited in close vessels, they yield as a fixed residue *Bone Black* (see p. 318 and 331). If, however, they be calcined in open vessels, the whole of the carbonaceous matter is burnt off, and the white product is called *Bone Ash* (*Ossa usta alba; Ossa*

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[m] *Phil. Trans* for 1797.

[n] Berzelius, *Traité de Chimie*, t. iv.

de usta; Ossa ad albedinem usta; Ossa calcinata; Spodium album,) or the *Bone Earth* (*Terra Ossium*).

A similar product is obtained by calcining the antlers (*Cornua*) of the Deer (*Cervus*). In this case the product, when reduced to a fine powder, is called *Burnt Hartshorn.* (*Cornu ustum*, L.; *Pulvis Cornu Cervini usti*, D.). Finely powdered Bone Ash is, however, usually substituted in the shops for Burnt Hartshorn.

The *Dublin College* gives the following directions for the preparation of *Precipitated Phosphate of Lime* (*Calcis Phosphas præcipitatum*, D.)

Take of Bones, burnt and reduced to powder, *one part;* Diluted Muriatic Acid; Water, of each, *two parts.* Digest them together during twelve hours, and filter the liquor: add to this, of water of Caustic Ammonia as much as may be sufficient to throw down the Phosphate of Lime. Let this be washed with a sufficiently large quantity of water, and then dried.

Bone ash is composed principally of subphosphate with a little carbonate of lime. By digestion with hydrochloric acid, the subphosphate is dissolved, and the carbonate is decomposed with the evolution of carbonic acid and the formation of water and chloride of calcium. On the addition of ammonia, the subphosphate is precipitated. It is washed to deprive it of all traces of chloride of calcium and muriate of ammonia.

PROPERTIES.—Subphosphate of lime is white, tasteless, odourless, insoluble in water, but soluble in nitric, hydrochloric, and acetic acids, from which solutions it is thrown down, unchanged in composition, by ammonia, potash, and their carbonates. When exposed to a very intense heat, it fuses, and undergoes no other change.

Characteristics.—It is known to be a phosphate by its solubility in hydrochloric acid, and its being again thrown down as a white precipitate when the acid solution is supersaturated with caustic ammonia. If it be digested in a mixture of sulphuric acid and alcohol, sulphate of lime is precipitated, and an alcoholic solution of phosphoric acid obtained. The acid may then be recognised by the tests for it already mentioned (p. 454). If the precipitated sulphate of lime be dissolved in water, the solution may be known to contain lime by the tests before described for the calcareous salts (p. 578). The subphosphate of lime of bones is distinguished from the neutral phosphate by its fusing with greater difficulty, and dissolving more readily in hydrochloric acid. A very delicate test of the neutral phosphate is its crystallizing from hydrochloric acid by evaporation[o].

COMPOSITION.—The composition of subphosphate of lime is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*
Lime	8	224	51·0	51·55
Phosphoric Acid	6	216	49·0	48·45
Bone Subphosphate of Lime	1	440	100·0	100·00

PHYSIOLOGICAL EFFECTS.—Its effects are not very obvious. "As phosphate of lime is very difficultly soluble," observes Wibmer[p], "it is absorbed in small quantity only, and then acts more or less like lime, as a slight astringent on the tissues and secretions, and increases, incontestibly, the presence of calcareous salts in the bones, the blood, and the urine. Large doses disorder the stomach and digestion by their difficult solubility."

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[o] Wollaston, *Phil. Trans.* for 1797, p. 396 & 397.

[p] *Die Wirkung,* &c. ii. 9.

USES.—It has been administered in rickets, with the view of promoting the deposition of bone-earth in the bones. The sesquioxide of iron may be advantageously conjoined with it. Its principal use is in the preparation of phosphorus (p. 450) and phosphate of soda (p. 547). In the arts it is employed for polishing, for the preparation of cupels, &c.

ADMINISTRATION.—Dose from grs. x. to ʒss. For internal use the preparation of the Dublin College is to be preferred.

ORDER 15. COMPOUNDS OF MAGNESIUM.

1. MAGNE'SIA, *L. E. D.*—MAGNESIA.

HISTORY.—It was first chemically distinguished from lime in 1755, by Dr. Black, who also shewed the difference between magnesia and its carbonate. From the mode of procuring it, it is frequently termed *Calcined* or *Burnt Magnesia* (*Magnesia calcinata* seu *usta*). It is sometimes called *Talc Earth* (*Talkerde*), or *Bitter Earth* (*Bittersalzerde*).

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—Magnesia is found native, in the solid state or in solution, in sea or some mineral waters, in combination with water and various acids (carbonic, sulphuric, boracic, silicic, and nitric). Chloride of magnesium exists in sea water, as also in some springs.

β. IN THE ORGANISED KINGDOM.—Combined with acids it is found in some vegetables (as *Salsola Kali* and *Fucus vesiculosus*), and animals (as in the urine and some urinary calculi of man).

PREPARATION.—It is prepared by submitting the common carbonate of magnesia to heat, whereby the carbonic acid is driven off.

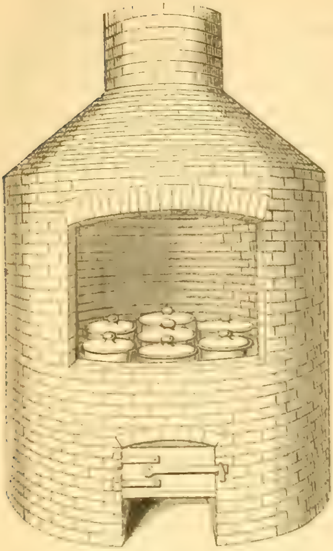
The *Edinburgh College* gives the following directions for preparing it:—"Take any convenient quantity of Carbonate of Magnesia, expose it in a crucible to a full red heat for two hours, or till the powder, when suspended in water, presents no effervescence on the addition of muriatic acid. Preserve the product in well-closed bottles."

The directions of the *London* and *Dublin Colleges* are essentially similar.

The operation is usually conducted in large, porous, covered crucibles, placed in a furnace expressly devoted to this operation, and heated by coke (fig. 102).

PROPERTIES. — It is a light, fine, white, colourless, odourless, and tasteless powder, having a sp. gr. 2·3. When moistened with water it reacts as an alkali on test papers. It is very slightly soluble in water, and like lime is more soluble in cold than in hot water. Dr. Fyffe states that it requires 5142 parts of cold, and 36000 parts of hot water to dissolve it. Unlike lime it evolves scarcely any heat

Fig. 102.



Furnace for the preparation of Calcined Magnesia.

when mixed with water. By the combined voltaic and oxy-hydrogen flames it has been fused by Mr. Brande[p]. It absorbs carbonic acid slowly from the atmosphere.

Characteristics.—It is soluble in the dilute mineral acids without effervescence. The dilute solution does not occasion any precipitate with the ferrocyanides, hydrosulphurets, oxalates, or bicarbonates. The neutral alkaline carbonates, when unmixed with any bicarbonate, throw down a white precipitate *(carbonate of magnesia)*. Ammonia with phosphate of soda causes a white precipitate *(ammoniacal-phosphate of magnesia)*. Magnesia is insoluble in alkaline solutions, and is thereby distinguished from alumina. Its solution in sulphuric acid is remarkable for its great bitterness.

Composition.—Magnesia has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Wollaston.*	*Gay-Lussac.*	*Berzelius.*
Magnesium	1	12	60	59·3	59·5	61·29
Oxygen	1	8	40	40·7	40·5	38·71
Magnesia	1	20	100	100·0	100·0	100·00

Purity.—Its freedom from any carbonate is shewn by its dissolving in dilute mineral acids without effervescence. Its hydrochloric solution should occasion no precipitate with the oxalates, bicarbonates, and barytic salts, by which the absence of lime and sulphates may be inferred.

Dissolves in hydrochloric acid without effervescence. Neither bicarbonate of potash nor chloride of barium throws down any thing from the solution. It turns turmeric slightly brown. *Ph. Lond.*

"Fifty grains are entirely soluble, without effervescence, in a fluidounce of [pure] muriatic acid: an excess of ammonia occasions in the solution only a scanty precipitate of alumina: the filtered fluid is not precipitated by solution of oxalate of ammonia."

The quantity of hydrochloric acid directed to be used by the Edinburgh College is unnecessarily large.

Physiological Effects.—When taken into the stomach, magnesia neutralizes the free acids contained in the stomach and intestines, and forms therewith soluble magnesian salts. In full doses it acts as a laxative; but as it occasions very little serous discharge,

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[p] *Manual of Chemistry.*

Dr. Paris[r] ranks it among purgatives "which urge the bowels to evacuate their contents by an imperceptible action upon the muscular fibres." Part of its laxative effect probably depends on the action of the soluble magnesian salts which it forms by union with the acids of the alimentary canal. Magnesia exercises an influence over the urine analogous to that of the alkalis: that is, it diminishes the quantity of uric acid in the urine, and when continued for too long a period occasions the deposit of the earthy phosphates in the form of white sand[s]. On account of its greater insolubility, it requires a longer time to produce these effects than the alkalis. When taken in too large quantities and for a long period it has sometimes accumulated in the bowels to an enormous extent, and being concreted by the mucus of the bowels, has created unpleasant effects. A lady took every night during two years and a half, from one to two teaspoonfuls of Henry's calcined magnesia (in all between 9 and 10 lbs. troy) for a nephritic attack, accompanied with the passage of gravel; subsequently she became sensible of a tenderness in the left side just above the groin, connected with a deep-seated tumor, obscurely to be felt on pressure, and subject to attacks of constipation, with painful spasmodic action of the bowels, tenesmus, and a highly irritable state of stomach. During one of these attacks she evacuated two pints of "sand;" and on another occasion voided soft light brown lumps, which were found to consist entirely of carbonate of magnesia concreted by the mucus of the bowels, in the proportion of 40 per cent. In another case a mass of a similar description, weighing from 4 to 6 lbs., was found imbedded in the head of the colon, six months after the patient had ceased to employ any magnesia[t].

USES.—As an *antacid* it is as efficacious as the alkalis, while it has an advantage over them in being less irritant, and thereby is not so apt to occasion disorder of the digestive organs. It may be employed to neutralize acids introduced into the stomach from without, (as in cases of poisoning by the mineral acids) or to prevent the excessive formation of, or to neutralize when formed, acid in the animal economy. Thus it is administered to relieve heartburn arising from, or connected with, the secretion of an abnormal quantity of acid by the stomach; its efficacy is best seen in persons of a gouty or rheumatic diathesis, in which the urine contains excess of uric acid. It often relieves the headache to which such individuals are not unfrequently subject. It is most efficacious in diminishing the quantity of uric acid in the urine, in calculous complaints, and according to Mr. W. T. Brande[u] it is sometimes effectual where the alkalis have failed. It will be found of great value in those urinary affections in which alkaline remedies are indicated, but in which potash and soda have created dyspeptic symptoms. It is a most valuable anti-emetic in cases of sympathetic vomiting, especially that which occurs during pregnancy[v]. It should be given in doses of from a scruple to a drachm in simple water or chicken broth.

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[r] *Pharmacologia*, vol. i. art. *Cathartics*.

[s] W. T. Brande, *Phil. Trans.* 1810, p. 136; and 1813, p. 213.

[t] E. Brande, *Quart. Journ. of Science*, i. 297.

[u] *Phil. Trans.* 1813, p. 213.

As a *laxative*, magnesia is much employed in the treatment of the diseases of children. It is tasteless, mild in its operation, and antacid,—qualities which render it most valuable as an infant's purgative. Independently of these, Hufeland ascribes to it a specific property of diminishing gastro-intestinal irritation by a directly sedative influence. In flatulency it is combined with some carminative water (dill or anise); in diarrhœa, with rhubarb. It is employed as a purgative by adults in dyspeptic cases—in affections of the rectum, as piles and stricture—and in diarrhœa. It is associated with the carminative waters—with some neutral salts, as sulphate of magnesia, to increase its cathartic operation—or, in diarrhœa, with rhubarb.

ADMINISTRATION.—As a purgative, the dose, for adults, is from a scruple to a drachm; for infants, from two to ten grains. As an antacid, the dose is from ten to thirty grains twice a-day. It may be conveniently given in milk. It is sometimes administered in combination with lemon juice: the *citrate of magnesia* thus formed acts as a pleasant and mild aperient.

2. MAGNE'SIÆ CAR'BONAS, *L. E. D.*—CARBONATE OF MAGNESIA.

HISTORY.—Carbonate of magnesia, also called *Magnesia Alba* and *Subcarbonate of Magnesia*, was exposed for sale at Rome at the commencement of the 18th century, by Count di Palma, in consequence of which it was termed *Comitissæ Palmæ pulvis*. In 1707, Valentini informed the public how it might be prepared.

NATURAL HISTORY.—Native, anhydrous, neutral carbonate of magnesia is found in various parts of Europe, Asia, and America. Carbonate of magnesia is found in some mineral waters.

The native neutral carbonate of magnesia constitutes a range of low hills in Hindostan. Some years ago a cargo of it was brought over by Mr. Babington. Dr. Henry[w] analyzed a sample of it, and found its constituents to be *magnesia*, 46; *carbonic acid*, 51; *insoluble matter*, 1·5; *water*, 0·5; and *loss*, 1· = 100.

Native carbonate of magnesia, from India, has been imported in considerable quantities into this country; but has been found, as I am informed, unsaleable here. The samples offered for sale in the year 1837 consisted of reniform, opaque, dull masses, adherent to the tongue, having a conchoidal fracture, and considerable hardness. Internally, they were whitish; externally, they were greyish, or yellowish white.

The same substance (I presume) was brought over in 1838 in the calcined state, and was offered for sale as *Indian Calcined Magnesia*. It was nearly white.

PREPARATION.—All the British Colleges give directions for the preparation of carbonate of magnesia.

The *London College* orders of Sulphate of Magnesia. lbiv.; Carbonate of Soda, lbiv. and ℥viij.; Distilled Water, *Cong.* iv. Dissolve separately the carbonate of soda and sulphate of magnesia in two gallons of the water, and strain; then mix and boil the liquors, stirring constantly with a spatula for a quarter of an hour; lastly, the liquor being poured off, wash the precipitated powder with boiling distilled water, and dry it.

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[v] Dr. Watson, in the *Medical Observ. and Inquiries*, vol. iii. p. 335. Lond. 1769, 2d ed.

[w] *Annals of Philosophy*, N. S. vol. i. p. 252.

The *Edinburgh College* employs the same proportions of ingredients, and gives similar directions for the preparation of this compound.

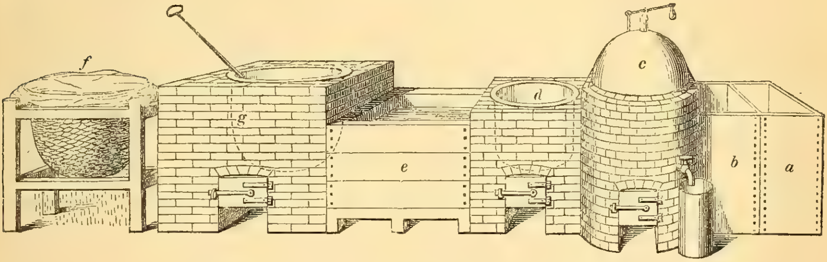
The *Dublin College* uses of Sulphate of Magnesia, *twenty-five parts;* Carbonate of Potash, *twenty-four parts;* Boiling Water, *four hundred parts.*

Two kinds of carbonate of magnesia are known and kept in the shops;—the *light* and the *heavy.*

α. *Light Carbonate of Magnesia; Common Magnesia.*—This is manufactured in the northern parts of this island, and is commonly known as *Scotch Magnesia.* It is said to be prepared from the residuary liquor (*bittern*) of sea water, after the extraction of common salt (see p. 532).

β. *Heavy Carbonate of Magnesia; Magnesia Ponderosa.*—The following is the method which I have seen followed in a large and esteemed manufactory:—Add one volume of a cold saturated solution of carbonate of soda to a boiling mixture of one volume of a saturated solution of sulphate magnesia, and three volumes of water. Boil until effervescence has ceased, constantly stirring with a spatula. Then dilute with boiling water, set aside, pour off the supernatant liquor, and wash the precipitate with hot water on a linen cloth: afterwards dry it by heat in an iron pot.

Fig. 103.



Manufactory of Heavy Carbonate of Magnesia.

a. Cistern containing the solution of the Sulphate of Magnesia.
b. Ditto containing solution of Carbonate of Soda.
c. Boiler for supplying hot water.
d. Ditto for the mixed solutions.
e. A back in which the Carbonate of Magnesia is deposited.
f. Filter (linen cloth supported in a basket, contained in a wooden stand).
g. Iron pot for drying the Carbonate of Magnesia.

A *heavy* and *gritty Carbonate of Magnesia* is prepared by separately dissolving twelve parts of sulphate magnesia and thirteen parts of crystallized carbonate of soda in as small a quantity of water as possible, mixing the hot solutions, and washing the precipitate.

When cold solutions of sulphate of magnesia and carbonate of soda are mixed, and no heat is employed, the product is apt to be gritty. According to Professor Graham[y], carbonate of soda is not so suitable as carbonate of potash for precipitating magnesia, "as a portion of

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[x] *Elements of Chemistry*, p. 505.

it is apt to go down in combination with the magnesian carbonate; but it may be used provided the quantity applied be less than is required to decompose the whole magnesian salt in solution."

By the mutual re-action of solutions of sulphate of magnesia and carbonate of soda, we obtain, by double decomposition, sulphate of soda and carbonate of magnesia.

MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Sulphate Magnesia	60	*1 eq. Sulphuric Acid*	40	1 eq. Sulphate Soda	72
		1 eq. Magnesia	20		
1 eq. Carbonate Soda ..	54	*1 eq. Soda*	32		
		1 eq. Carbonic Acid	22	1 eq. Carb. Magnesia	42
	114		114		114

During the ebullition, however, part of the carbonic acid escapes, and the product, therefore, is not a neutral carbonate, as will be shewn presently.

Berzelius[y] states, that the neutral carbonate is decomposed by cold water into bicarbonate, which is dissolved in the liquid, and a subsalt which is precipitated. Boiling water, he adds, causes the disengagement of carbonic acid without dissolving any thing. "The crystallized carbonate of magnesia loses a third of its carbonic acid, and two-thirds of its water, when it is decomposed by boiling water" (*Berzelius*). The compound obtained by ebullition is fixed and unalterable.

PROPERTIES.—Carbonate of magnesia, as usually met with, is in the form of a white, inodorous, and almost tasteless powder. The *common* or *light* variety occurs in commerce as a very fine light powder, of which 48 grains lightly fill an ounce measure[z]. It is also met with in large rectangular masses with bevelled edges, or in smaller cubical cakes. The light powder mixes imperfectly with water. Its taste, in a copious draught, is somewhat disagreeable, owing probably to its having been imperfectly washed. The *heavy* carbonate is, as its name indicates, of greater specific gravity than the light. 160 grains of it lightly fill an ounce measure. It is tasteless, or nearly so. Both kinds mixed with water have a feebly alkaline reaction on test paper. Carbonate of magnesia is nearly insoluble in water: it readily dissolves in carbonic acid water.

Characteristics.—It is distinguished from caustic or calcined magnesia by the effervescence which takes place on the addition of a dilute mineral acid. Its other characteristics are the same as for the latter substance (vide p. 602).

COMPOSITION.—The following is the composition of Carbonate of Magnesia of the shops:—

	Kirwan.	*Bergman.*	*Klaproth.*	*Bucholz.*		*Berzelius.*	*Phillips.*
				Light.	Heavy.		
Magnesia	45	45	40	33	42	44·75	40·8
Carbonic Acid	34	25	33	32	35	35·77	36·0
Water........	21	30	27	35	23	19·48	23·2
Magnesia alba	100	100	100	100	100	100·00	100·0

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[y] *Traité de Chimie*, t. iv.

[z] West, *Lond. Med. Gaz.* vol. ix. p. 356.

Several reasons have led chemists to reject the idea of this compound being an ordinary subsalt [a].

Mr. Phillips [b] considers it to be probably a compound of

	Atoms.	*Eq. Wt.*			*Per Cent.*
Bihydrated Magnesia	1	38	or	Carbonic Acid	36·3
Hydrated Carbonate of Magnesia	4	204		Magnesia	41·3
				Water	22·4
Carbonate Magnesia, *Ph. L.*	1	242			100·0

Mr. Brande [c], on the other hand, says that it probably consists "of 1 atom quadrihydrate and 1 atom of carbonate," or perhaps of 1 atom terhydrate and 1 atom of hydrated carbonate.

Purity.—Carbonate of magnesia should be perfectly white and tasteless. The water in which it has been boiled should have no alkaline reaction on turmeric paper, nor throw down anything on the addition of chloride of barium or nitrate of silver: by which the absence of alkaline carbonates, sulphates, and chlorides, is proved. Dissolved in dilute acetic acid the soluble oxalates and carbonates should occasion no precipitate, by which the non-existence of any calcareous salt is shewn.

The water in which it is boiled does not alter the colour of turmeric; chloride of barium or nitrate of silver, added to the water, does not precipitate any thing. One hundred parts dissolved in dilute sulphuric acid lose 36·6 parts in weight. When the effervescence has ceased, bicarbonate of potash does not precipitate any thing from this solution. *Ph. Lond.*

"When dissolved in an excess of muriatic acid, an excess of ammonia occasions only a scanty precipitate of alumina; and the filtered fluid is not precipitated by oxalate of ammonia." *Ph. Ed.*

Physiological Effects.—The effects of carbonate of magnesia are nearly the same as those of pure magnesia. We can readily conceive that the local operation of the first is somewhat milder than that of the latter (as in the case of the alkalis and their carbonates), but the difference is hardly perceptible in practice. As the carbonate effervesces with acids it is more apt to create flatulence when swallowed.

Uses.—The uses of the carbonate are the same as those of calcined magnesia: except where the object is to neutralize acid in the alimentary canal (as in cardialgia and in poisoning by the mineral acids), when the latter preparation is to be preferred on account of its not effervescing with acids, and thereby not causing flatulency. It is employed in the preparation of medicated waters (see p. 258).

Administration.—The dose of carbonate of magnesia, as a purgative, is from ten grains to a drachm; as an antacid, from five grains to a scruple. It is sometimes given with citric acid in an effervescing form. I find that ℈j. of crystallized citric acid saturates about 14 grs. of either light or heavy magnesia. The product of their reaction is *citrate of magnesia.*

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[a] Vide Berzelius, *Traité de Chim.* vi. 101.

[b] *Translation of the Pharmacopœia,* 4th ed.

[c] *Manual of Chemistry,* 5th edit. p. 714.

1. TROCHISCI MAGNESIÆ, E. *Magnesia Lozenges.* (Carbonate of Magnesia, ℥vj.; Pure Sugar, ℥iij.; Nutmeg, ℈j. Pulverize them, and, with mucilage of Tragacanth, beat them into a proper mass for making lozenges.)—Employed to counteract acidity of stomach.

2. AQUA MAGNESIÆ BICARBONATIS; *Carbonated Magnesia Water; Aerated Magnesia Water; Condensed Solution of Magnesia; Fluid Magnesia.*—This is a solution of carbonate of magnesia in carbonic acid water. Mr. Dinneford prepares it as follows:—Howard's heavy carbonate of magnesia and distilled water (in the proportion of 17½ grs. of the former to f℥j. of the latter) are introduced into a cylindrical tinned copper vessel, and carbonic acid (generated by the action of sulphuric acid on whiting) is forced into it, by means of steam power, for five hours and a half, during the whole of which time the cylinder is kept revolving. The liquid, which is then perfectly clear and transparent, is drawn off, and preserved in cylindrical zinc canisters, each closed by a cork covered by a lid. When this solution is exposed for some time to the air, carbonic acid escapes, and minute prismatic crystals are deposited, which Dr. Davy[d] analysed, and found to consist of—

	Atoms.	*Eq. Wt.*	*Dr. Davy.*
Magnesia	1½	30	29·61
Carbonic Acid	1½	33	32·22
Water expelled at 212°	1	9	10·27
Ditto ditto by ignition	3	27	27·90
Hydrated Carbonate of Magnesia	1	99	100·00

An extemporaneous solution of carbonate of magnesia may be prepared by pouring the ordinary soda water (carbonic acid water) over the common carbonate of magnesia contained in a tumbler. Or a mixture of crystallized sulphate of magnesia and crystallized carbonate of soda, in powder, and in atomic proportions (viz. 123 parts of the former to 144 parts of the latter salt) may be substituted for the carbonate of magnesia.

Carbonated magnesia water is a very agreeable and effective form for the administration of magnesia.

3. MAGNE'SIÆ SUL'PHAS, *L. E. D.*—SULPHATE OF MAGNESIA.

History.—This salt was originally procured from the Epsom waters by Dr. Grew[e]. It has had a variety of names, such as *Epsom* or the *Bitter Purging Salt*, *Sal Anglicum*, *Sal Seidlitzense*, *Sal Catharticum*, and *Vitriolated Magnesia.*

Natural History.—It is a constituent of sea and many mineral waters: it occurs as an efflorescence on other minerals, forming the *Hair Salt* of mineralogists; and with sulphate of soda and a little chloride of magnesium, constitutes *Reussite.*

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[d] *Lond. and Edinb. Phil. Mag.* vol. xvii. p. 346. 1840.

[e] *A Treatise of the Nature and Use of the Bitter Purging Salt.* Lond. 1697.

Preparation.—The two great sources of the sulphate of magnesia of English commerce are *Dolomite* and *Bittern.*

a. **From Dolomite.**—Dolomite or Magnesian Limestone is a mixture or combination of the carbonates of magnesia and lime. It crystallizes in rhombohedrons. It occurs in enormous quantities in various counties of England (as those of Somerset, York, and Nottingham), and is employed for building: York Minster and Westminster Hall are built of it.

Various methods of manufacturing sulphate of magnesia from dolomite have been proposed and practised. One method is to heat this mineral with dilute sulphuric acid: carbonic acid escapes, and a residue, composed of sulphate of magnesia and sulphate of lime, is obtained. These two salts are separated from each other by crystallization.

In 1816, Dr. William Henry, of Manchester[f], took out a patent for the following process:—Calcine magnesian limestone, so as to expel the carbonic acid; then convert the caustic lime and magnesia into hydrates by moistening them with water. Afterwards add a sufficient quantity of hydrochloric (or nitric or acetic) acid (or chlorine), to dissolve the lime, but not the magnesia, which, after being washed, is converted into sulphate by sulphuric acid (or, where the cost of this is objectionable, by sulphate of iron, which is easily decomposed by magnesia). Or the mixed hydrates of lime and magnesia are to be added to bittern: chloride of calcium is formed in solution, while two portions of magnesia (one from the bittern, the other from the magnesian lime) are left unacted on. Or hydrochlorate of ammonia may be used instead of bittern: by the reaction of this on the hydrated magnesian lime, chloride of calcium and caustic ammonia remain in solution, while magnesia is left undissolved: the ammonia is separated from the decanted liquor by distillation.

Carbonate of ammonia has also been employed to separate lime from magnesia: carbonate of lime is precipitated, and the magnesia remains in solution, from which it may be easily separated by ebullition[g].

β. **From Bittern.**—*Bittern* or the *Bitter Liquor* is the residual liquor of sea-water, from which common salt (chloride of sodium) has been separated (see p. 532). At Lymington, in Hampshire, sulphate of magnesia (called *physical salt*) is manufactured from bittern during the winter season. The liquor is boiled for some hours in the pans used during the summer for the preparation of common salt. During the ebullition some common salt is deposited. The lighter impurities are removed by skimming, and the concentrated solution is removed into wooden coolers, where in 24 hours one-eighth part of crystals of sulphate (called *Single Epsom Salts,* or simply *Singles*) are deposited. These are drained, dissolved, and recrystallized: they are then denominated *Double Epsom Salts,* or simply *Doubles.* Four or five tons of sulphate are obtained from brine which has yielded 100 tons of common salt and 1 ton of cat salt[h]. No sulphuric acid is employed in the process at Lymington ; but, if this acid be added to the residual liquor, a further quantity of sulphate may be obtained by the decomposition of the chloride of magnesium.

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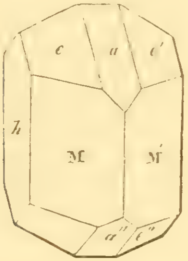
[f] *Repert. of Arts,* vol. xxx. p. 142, 2d Ser.

[g] *Journ. of Science,* iii. 217; vi. 313; ix. 177.

At Monte della Guardia, near Genoa, sulphate of magnesia is manufactured from schistose minerals, containing sulphur, magnesia, copper, and iron. After being roasted, and moistened to convert them into sulphates, they are lixiviated, and the solution is deprived, first, of copper by refuse iron, and afterwards of iron by lime[i]. In Bohemia, sulphate of magnesia is procured, by evaporation, from the waters of Seidlitz and Saidschütz. Hermann[j] extracts it from liquids containing chloride of magnesium, by means of sulphate of soda. At Baltimore, sulphate of magnesia is procured from the siliceous hydrate of magnesia or *marmolite*, by reducing the mineral to powder, saturating with sulphuric acid, and calcining the dried mass to peroxidize the iron. It is then re-dissolved in water (from which solution the remaining iron is separated by sulphuret of lime), and crystallized. By a second crystallization it is obtained nearly pure[k].

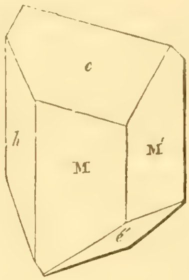
PROPERTIES.—The sulphate usually met with in the shops is in small acicular crystals. By solution and re-crystallization we readily obtain tolerably large four-sided rhombic prisms, with reversed dïedral summits, or four-sided pyramids: the crystals belong to the right prismatic system. Both large and small crystals are colourless, transparent, and odourless, but have an extremely bitter taste. When heated they undergo the watery fusion, then give out their water of crystallization, become anhydrous, and at a high temperature undergo the igneous fusion, and run into a white enamel, but without suffering decomposition. Exposed to the air they very slowly and slightly effloresce. They dissolve in their own weight of water at 60°, and in three-fourths of their weight of boiling water. They are insoluble in alcohol.

FIG. 104.



Common Crystal.

FIG. 105.



Crystal with dïedral reversed summits.

Characteristics.—Sulphate of magnesia is known to contain sulphuric acid by the tests for the sulphates already mentioned (p. 469). The nature of its base is shown by the tests for magnesia before described (p. 602).

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[h] Henry, *Phil. Trans.* for 1810.
[i] Dr. Holland, *Phil. Trans.* 1816, p. 294.
[j] Poggendorff's *Annalen*. xi. 249.
[k] D. B. Smith, in the *Dispensatory of the U. S. of America.*

Composition.—The following is the composition of crystallized sulphate of magnesia:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*	*Wenzel.*
Magnesia	1	20	16·26	16·04	16·86
Sulphuric Acid	1	40	32·52	32·53	30·64
Water	7	63	51·22	51·43	52·50
Crystal^{d} Sulphate of Magnesia	1	123	100·00	100·00	100·00

Purity.—The sulphate of magnesia met with in the shops is usually sufficiently pure for all medicinal and pharmaceutical purposes. It should be colourless, and its dilute solution should undergo no change when mixed with ferrocyanides or hydrosulphurets. When obtained from bittern it is sometimes contaminated with chloride of magnesium, which, by its affinity for water, keeps the sulphate in a damp state. By digestion in alcohol the chloride is dissolved; and, by evaporation, the spirituous solution may be obtained in the solid state. It is said, that occasionally small crystals of sulphate of soda are intermixed with those of sulphate of magnesia—a fraud I have never met with in English commerce, nor is it likely to occur at the present low price of the magnesian salt. Should such an adulteration be suspected, there are several methods of detecting it: the sophisticated salt would effloresce more rapidly than the pure salt, and would communicate a yellow tinge to the flame of alcohol. Boiled with caustic lime and water, all the magnesian sulphate would be decomposed, and the liquor being filtered (to separate the precipitated magnesia and sulphate of lime) would yield, on evaporation, sulphate of soda. If shaken in the cold with carbonate of baryta, a solution of carbonate of soda would be obtained, easily recognised by its alkaline properties.

Very readily dissolved by water. Sulphuric acid dropped into the solution does not expel any hydrochloric acid. 100 grs. dissolved in water, and mixed with a boiling solution of carbonate of soda, yield 34 grains of carbonate of magnesia when dried. *Ph. Lond.*

The evolution of hydrochloric acid gas would be a proof of the presence of a chloride. If less than 34 grs. of carbonate of magnesia be obtained, the presence of sulphate of soda may be suspected.

"Ten grains dissolved in a fluidounce of water, and treated with a solution of carbonate of ammonia, are not entirely precipitated by 280 minims of solution of phosphate of soda." *Ph. Ed.*

Physiological Effects.—Sulphate of magnesia is a mild and perfectly safe antiphlogistic purgative, which promotes the secretion as well as the peristaltic motion of the alimentary canal. It is very similar in its operation to sulphate of soda, than which it is less likely to nauseate, or otherwise disorder the digestive functions, while it acts somewhat more speedily on the bowels. It does not occasion nausea and griping, like some of the vegetable purgatives, nor has it any tendency to create febrile disorder or inflammatory symptoms; but, on the other hand, has a refrigerant influence: hence it is commonly termed a cooling purgative. In small doses, largely diluted with aqueous fluids, it slightly promotes the action of other emunctories: thus, if the skin be kept cool, and moderate exercise be conjoined, it acts as a diuretic; whereas, if the skin be warm, it operates as a diaphoretic. Dr. Christison[1] mentions a case of supposed poisoning, in a boy of ten years old, by two ounces of Epsom salts. The symptoms were staggering, imperceptible pulse, slow and difficult breathing, extreme debility, and death within ten minutes, without vomiting. It may, however, be fairly doubted whether the Epsom salts were chargeable with these effects.

Uses.—On account of the mildness and safety of its operation, its ready solubility, and its cheapness, sulphate of magnesia is by far the most commonly employed purgative, both by the public and the profession[m]. The only objection to its use is its bitter and unpleasant taste. To state all the cases in which it is administered, would be to enumerate nearly the whole catalogue of known diseases. It must, therefore, be sufficient to mention, that it is excellently well adapted as a purgative for febrile and inflammatory diseases, obstinate constipation, ileus, lead colic, even incarcerated hernia, narcotic poisoning, &c. It may be used as an antidote in poisoning by the salts of lead and baryta.

Administration.—As a purgative it is usually administered in doses of from half an ounce to an ounce and a half; but if dissolved in a large quantity of water, a smaller dose will suffice. Thus, two drachms in half a pint or more of water, taken in the morning fasting, will act speedily, sufficiently, and mildly, in ordinary cases; and in delicate females, a drachm, or even less, in the above quantity of water, will usually produce the desired effect. Some carminative or aromatic (as peppermint water or tincture of ginger) is frequently conjoined, to obviate flatulency. In febrile and inflammatory diseases the solution may be acidulated with dilute sulphuric acid with great advantage; or the sulphate may be dissolved in the compound infusion of roses. It is frequently used as an adjunct to the compound infusion of senna, whose purgative effect it promotes, but whose griping tendency it is said to check. In dyspeptic cases, accompanied with constipation, it is conjoined with bitter infusions (as of quassia, gentian, calumba, &c.) As a purgative enema, an ounce or more of it may be added to the ordinary clyster. The *bitter* purging saline waters (see p. 270) contain sulphate of magnesia.

PULVIS SALINUS COMPOSITUS, E.; *Compound Saline Powder*. (Take of Pure Muriate of Soda, and Sulphate of Magnesia [of each], ℥iv.; Sulphate of Potash, ℥iij. Dry the salts separately with a gentle heat, and pulverize each, then triturate them well together, and preserve the mixture in well-closed vessels).—A mild, cooling, saline aperient. May be employed in habitual constipation. Dose, ʒij. or ʒiij. It may be taken dissolved in half a pint of plain water, or in bottled soda water (carbonic acid water).

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[1] *Treatise on Poisons,* 3d edit. p. 603.

[m] Sulphate of magnesia is extensively used in the diseases of cattle. In a letter which I have received from Mr. Youatt, Veterinary Surgeon to the Zoological Gardens, he says—"For cattle we use the sulphate of magnesia or soda. The former is preferable, on account of its easier solution. I purge the larger elephant, whenever I please, by giving him a drachm of calomel at night, and a pound and a half of Epsom salts in the morning."

ORDER XVI.—COMPOUNDS OF ALUMINUM.

ALU'MEN, *L. E. D.*—ALUM.

(Sulphas Aluminæ et Potassæ, *L. E. D.*)

HISTORY.—Although the term alum (*Alumen* of the Romans—*στυπτηρία* of the Greeks) occurs in the writings of Herodotus[n], Hippocrates[o], Pliny[p], Dioscorides[q], and other ancient writers, yet it is not satisfactorily proved that our alum was the substance referred to. On the contrary, the learned Beckmann[r] has asserted that the alum of the Greeks and Romans was sulphate of iron, and that the invention of our alum was certainly later than the 12th century. But Geber[s], who is supposed to have lived in the 8th century, was acquainted with three kinds of our alum, and describes the method of preparing burnt alum; and it is not, I think, improbable, that even Pliny was acquainted with our alum, but did not distinguish it from sulphate of iron, for he tells us that one kind of alum was white, and was used for dyeing wool of bright colours[t].

NATURAL HISTORY.—It is found native in the neighbourhood of volcanoes, and constitutes the mineral called *Native Alum.*

PREPARATION.—The method of preparing alum varies somewhat in different places. The mineral from which (in this country) it is procured is called *Aluminous Slate, Aluminous Shale*, or *Aluminous Schist* (*Schistus Aluminaris*). This substance varies somewhat in its composition in different localities, but always contains sulphuret of iron, alumina, carbon, and sometimes a salt of potash. In the neighbourhood of Glasgow there are two alum manufactories, one at Hurlet, the other at Campsie. The most extensive alum manufactory in Great Britain is at Hurlet, near Paisley. Here the aluminous schist lies between the stratum of coal and limestone[u]. By the action of the air it undergoes decomposition, and falls down on the floor of the mine. The sulphur attracts oxygen, and is converted into sulphuric acid, which combines partly with the iron (oxidized by the air), and partly with the alumina. The solution obtained by lixiviating the decomposed schist is evaporated, and the sulphate of iron allowed to crystallize: to the mother liquor, which contains sulphate of alumina, sulphate of potash, or chloride of potassium, obtained from soap-boilers, is added, by which crystals of alum are procured, which are purified by a second crystallization. Of late years, sulphate of ammonia, obtained from gas liquor, has been employed as a substitute for the sulphate of potash or chloride of potassium. In general the alum made at Hurlet contains both potash and ammonia [v].

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[n] *Euterpe*, clxxx.

[o] *De Fistulis, De Ulceribus*, &c.

[p] *Hist. Nat.* xxxv.

[q] Lib. v. cap. 123.

[r] *Hist. of Invent.* i. 288.

[s] *Search of Perfection*, ch. iii.; and *Invention of Verity*, ch. iv.

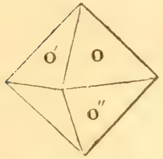
[t] For further information, consult Parkes' *Chemical Essays*, i. 625; and Thomson's *History of Chemistry*, i. 125.

[u] Williams, *Nat. Hist. of the Mineral Kingdom*, 2d edit. ii. 315.

At Whitby, in Yorkshire, the method of making alum is somewhat different. The schist is piled in heaps, and burnt by means of a slow smothered fire. The calcined ore is lixiviated, and a salt of potash added to the solution after it has deposited sulphates of lime and iron, and earthy matters [w].

Properties.—Alum crystallizes usually in regular octohedrons, frequently with truncated edges and angles, and sometimes in cubes. The ordinary alum of the shops consists of large crystalline masses, which do not present any regular geometrical form; but, by immersion in water during a few days, octohedral and rectangular forms are developed on its surfaces [x]. Alum has an astringent and sweetish acid taste: its reaction on vegetable colours is that of an acid. Its sp. gr. is 1·7. By exposure to the air it slowly and slightly effloresces. Its transcalent or diathermanous power is very slight. When heated, alum undergoes the watery fusion, swells up, gives out its water of crystallization, and becomes a white spongy mass, called *Dried Alum*. When submitted to a very strong heat, a portion of the acid is expelled, and escapes, partly as sulphuric acid, partly in the form of oxygen and sulphurous acid, and the residue consists of alumina and sulphate of potash: the acid liquor obtained by heating alum was formerly termed *Spirit of Alum*. When alum is calcined with charcoal or some carbonaceous substance, as sugar, we obtain a spontaneously inflammable substance called *Homberg's Pyrophorus*, composed of sulphur, potassium, aluminum or alumina, and charcoal.

Fig. 106.



Octohedron of Alum.

Alum dissolves in 18 times its weight of cold and less than its own weight of boiling water.

The alum procured at Tolfa and other parts of Italy, and called *Roman Alum* (*Alumen Romanum*), is covered with a pale, rose-coloured efflorescence, composed of oxide of iron and an aluminous sulphate of potash. Under the name of *Roche* or *Rock Alum* (*Alumen Rupeum*, seu *Alumen de Rochi*, so called from Roccha, in Syria, whence a red-coloured alum was formerly brought), we find in English commerce crystalline fragments of alum, not larger than almonds, coloured externally with bole or rose-pink.

Characteristics.—That alum is a sulphate is shewn by the tests for the soluble sulphates already mentioned (p. 469). It reddens litmus, and forms sulphate of lead when mixed with pure carbonate of lead: in these properties it agrees with the supersulphates. The nature of its basic constituents is shewn by the following tests:—The ferrocyanides, the oxalates, and hydrosulphuric acid, occasion no precipitate in a solution of alum. Hydrosulphuret of ammonia, the caustic alkalis and their carbonates, and phosphate of soda, throw down white precipitates: that produced by the alkalis is soluble in an excess of alkali, but is insoluble in solutions of the carbonated alkalis: these characters shew the presence of alumina. Potash is recognised by perchloric acid and bichloride of platinum (vide p. 481). Lastly, the crystalline form of the salt assists in recognising it.

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[v] Dr. T. Thomson, in *Athenæum* for 1840, p. 771.
[w] Winter, in *Nicholson's Journal*, vol. xxv.
[x] Daniell, *Quart. Journ.* i. 24.

COMPOSITION.—The composition of alum is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Thomson.*	*Berzel.*
Alumina	3	54	11·088	11 09	10·76
Potash	1	48	9·856	9·86	9·95
Sulphuric Acid	4	160	32·854	32·85	33·74
Water	25	225	46·201	46·20	45·55
Cryst^d^. Potash-Alum	1	487	99·999	100·00	100·00

or

	Atoms.	*Eq. Wt.*	*Per Cent.*
Sulphate of Alumina	3	174	35·728
Sulphate of Potash	1	88	18·069
Water	25	225	46·201
Cryst^d^ Potash-Alum	1	487	99·998

In the above table I have assumed, with Thomson and Phillips, that alumina is a protoxide of aluminum (1 eq. Aluminum = 10, and 1 eq. Oxygen = 8), and that its equivalent is 18. But, according to Berzelius, it is a sesquioxide (composed of 2 eq. Aluminum = 26·44, and 3 eq. Oxygen = 24). Moreover, he found only 24 eq. of water in crystals of alum. Hence alum is composed, according to him, of $KO, SO^3 + Al^2 O^3 3SO^3 + 24 HO$.

PURITY.—Alum should be colourless, completely soluble in water (by which the absence of uncombined earthy matter is shewn); with a solution of caustic potash or ammonia should form a colourless precipitate of hydrate of alumina soluble in excess of potash; and should not suffer any change of colour by the addition of tincture of nutgalls or hydrosulphuric acid. The ferro-sulphate of potash, sometimes mixed with alum, cannot be distinguished from the latter by its form, colour, or taste; but is readily detected by potash, which throws down oxide of iron, and by tincture of nutgalls, which communicates a bluish black colour to it.

It is entirely soluble in water. From the solution, ammonia or potash, when added, throws down alumina free from colour, which again dissolves when the potash is added in excess. *Ph. L.*

PHYSIOLOGICAL EFFECTS. *a. On Vegetables.*—Alum is probably injurious to plants[y].

β. On Animals.—Dogs support large doses of alum with impunity. Orfila[z] gave seven drachms of *crystallized* alum in powder to dogs: the animals retained it for from ten to thirty minutes, then vomited, and in an hour or two were apparently well. Two ounces of *burnt* alum in four ounces of cold water occasioned vomiting only. When the œsophagus was tied to prevent vomiting, death took place in five hours with symptoms of great exhaustion and diminished sensibility. On a post-mortem examination the mucous membrane of the stomach was found inflamed in the whole of its extent. One ounce of finely-powdered burnt alum applied to the subcutaneous cellular tissue of the thigh, caused excessive suppuration, and death in fifteen hours. Devergie[a] found burnt alum somewhat more active: he says 6½ drachms killed a dog when the œsophagus was tied, and 2 ounces when it was not tied. Moreover, he found burnt alum suspended in cold water, more active than when dissolved in warm water. Veterinarians employ it in doses of from 1 to 6 drachms for large animals. Bourgelat has seen a phthisical condition induced in horses by the use of alum in too great quantities[b].

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[y] De Candolle, *Physiol. Végét.* 1341.
[z] *Ann. d'Hyg. Publiq. et de Méd. Lég.* i. 235.

γ. *On Man.*—The immediate topical effect of a solution of alum is that of an astringent, namely, corrugation of fibres and contraction of small vessels, by virtue of which it checks or temporarily stops exhalation and secretion, and produces paleness of parts by diminishing the diameters of the small blood-vessels. It is by these local effects that alum, when taken internally, causes dryness of the mouth and throat, somewhat increases thirst, checks the secretions of the alimentary canal, and thereby diminishes the frequency and increases the consistency of the stools, as observed by Wibmer[c] in his experiments made on himself, with alum in doses of 3 grains dissolved in 5 drachms of water, and taken several times during the day.

But when alum is applied to a part in larger quantities, and for a longer period, the astriction is soon followed by irritation, and the paleness by preternatural redness. And thus taken internally in large doses, alum excites nausea, vomiting, griping, purging, and even an inflammatory condition of the intestinal canal,—effects which may be perhaps induced by small quantities in persons endowed with unusual or morbid sensibility of the stomach and bowels, as in the case of the lady in whom dangerous gastro-enteritis was apparently induced by a single dose of a solution containing between ten and twenty grains of burnt alum[d]. Ordinarily, however, tolerably large doses of alum may be given without any unpleasant effects. Thus, Professor Dumeril has given a drachm, properly diluted, in chronic diarrhœas, within twenty-four hours: Professor Marc, two drachms, in passive hemorrhages, within the same period of time: and MM. Kapeler and Gendrin have administered three drachms at one dose, in colica pictonum[e].

After its absorption, alum appears to act as an astringent, or astringent-tonic, on the system generally, and to produce more or less general astriction of the tissues and fibres, and a diminution of secretion. Such at least appears to be its effects in some passive hemorrhages and mucous discharges. Barbier[f] says, alum "irritates the lungs, and often produces cough," but I am not aware of any other practitioner having confirmed this statement. Kraus[h] observes, that the urine becomes remarkably acid from the use of alum.

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[a] *Méd. Légale*, ii. 653.

[b] Moiroud, *Pharm. Vétér.* 225.

[c] *Die Wirkung*, &c. i. 114.

[d] *Ann. d'Hyg. Publique et de Méd. Lég.* i.

[e] Devergie, *Méd. Lég.* ii. 656.

[f] *Traité Element. de Mat. Méd.* 2d ed. i. 440.

[g] *Heilmittellehre*, 255.

Uses.—Alum is employed both as an external or topical, and as an internal remedy.

a. As a topical remedy.—Solutions of alum are sometimes employed *to produce contraction or corrugation of the tissues*, and thereby to prevent displacements of parts, especially when accompanied with excessive secretion. Thus, it is used as a gargle in relaxation of the uvula with evident advantage. In the early stage of prolapsus of the rectum, a solution of alum, applied as a wash, is sometimes of service, especially when the disease occurs in infants. Washes or injections containing alum are of occasional benefit in prolapsus of the uterus.

In hemorrhages, whether proceeding from an exhalation or exudation from the extremities or pores of the minute vessels, or from the rupture of a blood-vessel, a solution, or, in some cases, the powder of alum, may be used with advantage as a *styptic*, to constringe the capillary vessels, and close their bleeding orifices. Thus in epistaxis, when it is considered advisable to arrest the hemorrhage, assistance may be gained by the injection of a solution of alum into the nostrils, or by the introduction of lint moistened with the solution. Where this fails to give relief, finely-powdered alum may be employed in the manner of snuff. In hemorrhage from the mouth or throat, gargles containing alum are useful. In hæmatemesis, as well as in intestinal hemorrhage, alum whey may be administered; though, of course, no reliance can be placed on it, as the hemorrhage usually depends on circumstances which astringents merely cannot be expected to obviate. In uterine hemorrhage, a sponge soaked in a solution of alum may be introduced into the vagina with good effect. To check the hemorrhoidal flux when immoderate, washes or enemata containing alum may be employed. To stop the bleeding after leech bites in children, a saturated solution, or the powder of alum, may be applied to the punctures.

In certain inflammations, alum has been used as a *repellent;* that is, it has been applied to the inflamed part in order to produce contraction of the distended vessels, and thereby to diminish the quantity of blood in the seat of the disease in a manner almost mechanical. Thus, in the first stage of ophthalmia, it is sometimes considered expedient to cut short the disease by the application of a strong astringent solution (as a saturated solution of alum or of acetate of lead). "It is not to be denied," observes Dr. Jacob[h], "that such applications may have the effect of arresting the progress of the disease at once; but, if they have not that effect, they are liable to produce an increase of irritation." But, as the details necessary for making the student acquainted with all the circumstances respecting the use of stimulating or astringent applications, in the first stage of ophthalmia, are too lengthened and numerous to admit of their proper discussion in this work, I must refer, for further particulars, to the essay of Dr. Jacob before quoted, as well as to the treatises of writers on ophthalmic surgery. I may, however, add, that whatever difference of opinion exists as to the propriety of these applications in the first stage of ophthalmia, all are agreed as to their value after the violence of vascular action has been subdued. In the treatment of the purulent ophthalmia of infants, no remedy is perhaps equal to an alum wash.

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[h] *Cyclopædia of Pract. Med.* art. *Ophthalmia.*

In angina membranacea, called by Bretonneau[i] diphtheritis, great importance has been attached to the employment of local applications. Of these, hydrochloric acid, calomel, and alum, have, in succession, been highly praised by this writer. In order to promote the expulsion of the false membrane, he recommends the insufflation of finely-powdered alum. This is effected by placing a drachm of it in a tube, and blowing it into the throat[j]. Velpeau has subsequently confirmed the statements of Bretonneau, and extended the use of alum to other inflammatory affections of the throat, as those arising in scarlatina, small-pox, &c. In these cases powdered alum may be applied to the affected parts by means of the index finger. Gargles containing this salt will be found useful in most kinds of sore throat, ulcerations of the mouth and gums, aphtha, &c. In inflammation of the uvula, accompanied with membraniform exudation, alum washes are serviceable both in children and adults[k].

Alum has been employed as an *astringent*, to diminish or stop excessive secretion from the mucous surfaces. Thus, a weak solution of this salt is used to repress the discharge in the latter stages of conjunctival inflammation; to check profuse ptyalism, whether from the use of mercury or other causes; and to remove gleet or leucorrhœa. In old-standing diarrhœas it has been administered, in combination with the vegetable astringents (kino, for example), with occasional advantage. It is also applied to check profuse secretion from ulcers.

β. As an internal remedy.—Alum has been employed, in conjunction with nutmeg, as a remedy for intermittents. Given just before the expected paroxysm, it has in some cases prevented it[l].

In the treatment of *lead colic*, alum has been found more successful than any other agent or class of remedies. It was first used in this disease by a Dutch physician, named Grashuis[m], and was afterwards administered in fifteen cases by Dr. Percival[n] with great success. Its efficacy has been fully established by Kapeler, physician to the Hôpital St.-Antoine, in Paris, and Gendrin[o], and by Dr. Copland[p], as well as by several other distinguished authorities. It allays vomiting, abates flatulence, mitigates pain, and opens the bowels more certainly than any other medicine, and frequently when other powerful remedies have failed. It should be given in full doses (as from a scruple to two drachms), dissolved in some demulcent liquid (as gum-water) every three or four hours. Opium and (according to Dr.

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[i] *Rech. sur l'Inflam. spéc. du Tissu Muqueux*, 1826.

[j] See also Trousseau and Pidoux, *Traité de Thérap.* ii. 291.

[k] Trousseau and Pidoux, *op. cit.*

[l] Cullen, *Materia Medica.*

[m] *De Colica Pictonum*, Amst. 1752, et *Append.* 1753.

[n] *Essays, Med. and Exper.* ii. 194.

[o] Quoted by Trousseau and Pidoux, *op. cit.*

[p] *Dict. of Med.* i. 374.

Copland) camphor may be advantageously conjoined. Kapeler also employs oleaginous enemata. The modus operandi of alum in lead colic is not very clear. The benefit has been ascribed by some to the chemical action of the sulphuric acid on the lead supposed to be contained in the intestines; and in support of this view must be mentioned the fact, that other sulphates (as those of magnesia, soda, zinc, and copper), as well as free sulphuric acid, have been successfully employed in lead cholic. But, on the other hand, the presence of lead in the primæ viæ or evacuations, and, consequently, the formation of sulphate of lead in saturnine colic, have not been demonstrated; though the experiments of Dr. C. G. Mitscherlich[q] have shewn, that when the acetate of lead is swallowed, the greater part of it forms an insoluble combination with the gastro-intestinal mucus, and in this state may remain some time in the alimentary canal. Moreover, alum has been found successful by Kopp[r] in other varieties of colic not caused by lead, and unaccompanied by constipation. Dr. Copland is disposed to ascribe the benefit of alum, and other sulphates, in lead colic, to their "exciting the action of the partially paralysed muscular coat of the bowels, and thereby enabling them to expel retained matters of a morbid or noxious description,"—an explanation which is inconsistent with the observation of Kopp just quoted.

Alum is administered internally in several other diseases, of which a brief notice only can be given. In passive or asthenic hemorrhages from distant organs; as hæmoptysis, menorrhagia and other uterine hemorrhages, hæmaturia, &c. In colliquative sweating, diabetes, gleet, gonorrhœa, and leucorrhœa. In the three latter diseases it may be combined with cubebs. Kreysig[s] has advised its use in dilatation of the heart and aortic aneurism. More recently Dzondi[t] has also recommended it in these diseases; and Sundelin[u] has mentioned a case of supposed dilatation of the heart, in which relief was gained by the use of alum. In chronic diarrhœa, alum is occasionally serviceable.

Administration.—The dose of alum is from ten grains to one or two scruples. It may be taken in the form of powder, or made into pills with some tonic extract, or in solution. To prevent nausea, an aromatic (as nutmeg) should conjoined. A pleasant mode of exhibition is in the form of *Alum Whey* (*Serum Aluminosum*, seu *Serum Lactis Aluminatum*), prepared by boiling two drachms of powdered alum with a pint of milk, then straining: the dose is a wine-glassful. The *Saccharum Aluminatum* of the Prussian Pharmacopœia is composed of equal parts of white sugar and alum: it may be given to children as well as adults. In prescribing alum, it is to be recollected that the vegetable astringents decompose it; by which the astringent property of the mixture is probably diminished.

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[q] *Müller's Archiv*, No. V. 353, 1836, quoted in *Brit. Ann. of Med.* vol. i. 204, 1837.

[r] *Denkwurdigkeit*, i. 342, quoted by G. A. Richter, *Ausführ. Arzneim.* Suppl. Bd. 515.

[s] *Die Krankh. d. Herzens*, Bd. ii. Abt. 2, S. 714, in Richter, *op. cit.*

[t] *Aeskulap.* Bd. 1, St. 1, 1821, in Richter.

[u] *Heilmittellehre*, ii. 278.

For topical uses, alum is used in the form of powder, solution, and poultice. Powder of crystallized alum is applied to the mouth and throat as before mentioned. Solutions of alum are made, for topical purposes, of various strengths, according to the object in view.

Antidote.—In a case of poisoning by alum, let the contents of the stomach be immediately evacuated. Promote vomiting by the use of tepid diluents. The inflammatory symptoms are to be combated by the usual antiphlogistic means. Magnesia has been employed, but is said by Devergie to be altogether useless.

1. **ALUMEN EXSICCATUM**, L. E. *Alumen siccatum*, D.; *Dried Alum; Alumen ustum; Burnt Alum.* (Let Alum liquefy in an earthen vessel over the fire: then let the fire be increased, until the ebullition has ceased, *L.*—The directions of the *Edinburgh* and *Dublin Colleges* are essentially the same; except that they order the dried alum to be reduced to powder.)—In the preparation of this substance care must be taken not to apply too great a heat, lest a portion of the acid be driven off as well as the water. On this account a shallow earthen vessel is preferable to a crucible. Dried alum has a more astringent taste and does not dissolve so readily in water as the crystallized salt. It is employed as a mild escharotic to destroy exuberant spongy granulations; as those commonly known under the name of proud flesh.

2. **LIQUOR ALUMINIS COMPOSITUS**, L.; *Compound Solution of Alum; Aqua Aluminosa Bateana*, or *Bates's Alum Water.* (Alum, Sulphate of Zinc, each ℥j.; Boiling Water, Oiij. Dissolve the Alum and Sulphate of Zinc together in the Water; afterwards strain.)—This solution is used as a detergent and astringent wash in old ulcers; when diluted, as a collyrium in mild conjunctival inflammation, as an injection in gleet and leucorrhœa, and as an application to chilblains and slight excoriations.

3. **PULVIS ALUMINIS COMPOSITUS**, E.; *Compound Powder of Alum.* (Alum, ℥iv.; Kino, ℥j. Mix them, and reduce them to fine powder.)—Astringent. Employed in hemorrhages from the stomach, bowels, and uterus; in old diarrhœas; and as an application to flabby indolent ulcers.

4. **CATAPLASMA ALUMINIS**, D.; *Cataplasm of Alum; Alum Poultice; Albumen Aluminosum.* (Whites of two Eggs; Alum, ʒj. Shake them together to make a coagulum.)—"In cases of chronic and purulent ophthalmia, it is applied to the eye between two folds of old linen. It has been praised as a good application to chilblains which are not broken[v]." "Another kind of alum poultice in use

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[v] Montgomery's *Observations on the Dublin Pharmacopœia.*

is made by coagulating milk with alum, and using the curd as a poultice."

OTHER COMPOUNDS OF ALUMINUM.

RED ARMENIAN BOLE; *Bolus Armena rubra.*—This is found in Armenia (whence its name), as well as in various parts of Europe. Bergmann found it to consist of *silica* 47, *alumina* 19, *magnesia* 6·2, *lime* 5·4, *iron* 5·4, *water* 7·5.

The substance sold by druggists as Red Armenian Bole is prepared by grinding together, in a mill, Pipe Clay and Red Oxide of Iron, and afterwards levigating. It is principally used in the preparation of tooth powder. (See p. 219.)

The *Lemnian Earth* (*Terra Lemnia*) is very similar to Armenian Bole. It is not, however, always red. It is dug up at Lemnos, formed into flat cylindrical pieces, which are stamped and sold under the name of *Terræ Sigillatæ*.

ORDER XVII. COMPOUNDS OF ARSENICUM.

AC'IDUM ARSENIO'SUM, *L.*—ARSENIOUS ACID.

(Arsenicum album, *E.*—Arsenici Oxydum album, *D.*)

HISTORY.—Arsenious acid, commonly termed *White Arsenic* (*Arsenicum album*) or *Oxide of Arsenic*, is first distinctly mentioned by Geber[w], who seems to have been also acquainted with Metallic Arsenic[x]. Hippocrates[y] employed 'Αῤῥενικὸν (*Orpiment*) and Σανδαράκη (*Realgar*) as topical remedies. Dioscorides[z] is the first author who uses the word 'Αρσενικὸν (*Orpiment*).

NATURAL HISTORY.—Arsenious acid is found at Andreasberg in the Hartz, at Joachimsthal in Bohemia, and at some few other places. It is a rare mineral.

Metallic arsenic (*Arsenicum*) is found native either alone or associated with other metals, or their sulphurets. It forms two native sulphurets, viz. *Orpiment* and *Realgar*. There are two native compounds of it with oxygen, namely, *Arsenious* and *Arsenic Acids*: the latter is found in combination with bases forming native *Arseniates*.

Orfila[a] asserts that arsenic exists in the bones of man and of several other animals. But the experiments of Dr. G. O. Rees[b], of MM. Danger and Flandin, and of the commissioners appointed by the French Academy of Sciences[c] to report on Marsh's apparatus, have failed to corroborate his statements.

PREPARATION.—Arsenious acid is prepared in Silesia, Bohemia, Saxony, and Cornwall.

At Altenberg, in Silesia, it is obtained from arsenical iron (*Mispickel*), composed of sulphur 20·65, iron 35·62, and arsenicum 43·73[d]. After being reduced to powder, the ore is roasted in a muffle furnace (fig. 107), by which the arsenicum is converted into arsenious acid, which is conveyed, in the state of vapour called *Flowers of Arsenic* or

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[w] *Invent. of Verity*, ch. vii.

[x] *Sum of Perfection*, book i. part iv. chap. ii.

[y] *De Ulceribus.*

[z] Lib. v. chap. xxi.

[a] *Journal de Chimie Médicale*, t. v. 11e Série, p. 632. Dec. 1839.—Also, the *Lond. and Edinb. Phil. Mag.* for April 1840.

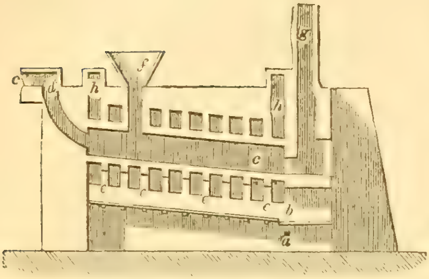
[b] *Guy's Hospital Reports*, No. xii.

[c] *Journal de Pharmacie*, t. xxvii. p. 428. Juillet 1841.

[d] Dumas, *Traité de Chimie*, t. iv. p. 120.

Smelting-house Smoke (*Hüttenrauch*), into the condensing chamber (fig. 108), where it is deposited in a pulverulent form, and in this state is called *Rough Arsenious Acid* or *Poison-flour (Giftmehl)*.

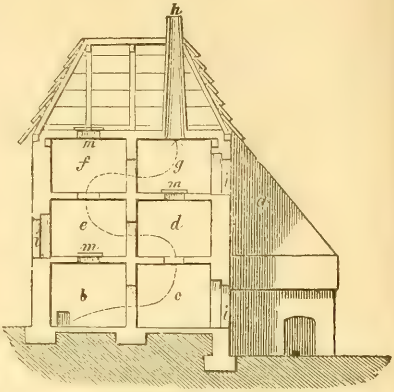
FIG. 107.



Section of the Roasting Furnace.

a. Ash-pit. *b*. Fire-place.
e,e,e. Brick arches for supporting the muffle.
c. Earthen muffle for receiving the ore.
d. Passage for the fumes into the condensing chamber.
f. Hopper for introducing the ore.
h,h. Flue.
g. Vent for protecting the workmen from the arsenical fumes.

FIG. 108.

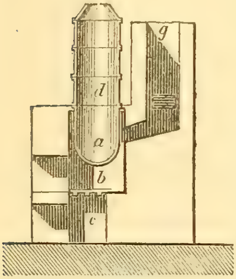


Condensing Chamber.

b, c, d, e, f, g, h. Course of the vapour.
i, i, i. Doors into the chamber.
m, m, m. Communications between the floors.

The rough acid is refined by sublimation. This is effected in cast-iron pots (fig. 109), to which cylindrical iron heads (*d*) are attached, which at the tops are contracted into cones (*e*), each terminating in a pipe made of sheet iron, and communicating with the condensing chamber (fig. 108). Heat is applied for twelve hours, by which the acid is sublimed and condensed on the sides of the iron head in the form of a glassy mass, called *Glacial White Arsenic* (*Weissen Arsenikglas*), which is sometimes purified by a second, or even third sublimation. If it contain any sulphuret of arsenicum, a little potash is mixed with it, to prevent the sublimation of the sulphur.

FIG. 109.



Refining Furnace.

c. Ash-pit. *b*. Fire-place.
a. Cast-iron pot.
d. Cylindrical head.
g. The chimney.

At Reichenstein, arsenious acid is procured from an arseniuret of iron, composed of iron 32·35, arsenic 65·88, and sulphur 1·77.

Arsenious acid is procured in some parts of Saxony as a secondary product in the roasting of cobalt ores (the arseniurets of cobalt). It is deposited in long horizontal flues (*Poison-flues*, or *Giftfängen*), and is purified by sublimation[e].

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[e] For further particulars consult the paper of J. H. Vivian, *Trans. Royal Geol. Society of Cornwall*, i. 60.

Arsenious acid is manufactured in Cornwall, from the White Mundie or Mispickel found with the tin ore. In the impure state it is deposited in the long horizontal flues of the burning houses[f]; from which it is taken for the use of refiners, its value being about ten shillings per ton[g]. In this condition it has a grey colour, and is either pulverulent or in soft crystalline masses. There are two arsenic works in the neighbourhood of Truro; one in the parish of Perran Arworthall, the other belonging to Mr. Conn, near Bissow Bridge, in the parish of Kea; the former about half a mile, the latter more than a mile, from the Devoran and Carnon steam-works. More recently a third manufactory has been set at work in the parish of Illogan, near Redruth.

The rough arsenious acid is brought to these works from the burning-houses in all parts of Cornwall. It is first separated from sulphur in a common reverberatory furnace, having a flue several hundred yards in length. The heat is low at first, and is gradually increased. By this means the sulphur is dissipated before the arsenic is volatilized. The process is carried on for several weeks, or even months. The fire is then extinguished, and the arsenic removed from the flue. The waste rubbish is used for destroying weeds, &c. in garden walks.

The arsenious acid thus obtained is then sublimed in conical cast-iron *kettles*, about 2½ feet high, and from 15 to 18 inches in diameter at the base. These kettles are hollow truncated cones, closed at the top by an iron plate perforated for an iron stopper; but open at the bottom. Ten or twelve of these kettles are placed in a circular form on an iron plate, to which they are clamped by a flanch. This plate forms the bottom to all the kettles, and is heated by a fire beneath. The rough arsenic is then introduced through the top aperture, and, heat being applied, is sublimed. Several charges are in this way introduced, until a sufficiently thick crust has been deposited within: the clamps are then taken off, and the kettle conveyed into the open air, where the crust is removed[h]. The fumes from these works are most injurious to neighbouring vegetables and animals. In the human subject eruptions, principally about the lips and nose, are produced by them[i].

In 1826, eighty-three tons of manufactured arsenic were shipped at Penryn[j]. At present, says Mr. Henwood, I believe not less than from 600 to 800 tons are prepared annually.

Properties.—When recently prepared, arsenious acid is in the form of large, glassy, transparent cakes, sometimes colourless, at others having a yellowish tinge. Frequently the cakes consist of concentric laminæ, formed by successive sublimations. These masses soon become opaque and white externally, like enamel, the opacity gradually extending towards the centre; and, in some cases, the acid becomes friable and pulverulent. Krüger[n] ascribes the change to the absorption of water from the atmosphere, for he says it only takes place in moist air, and is attended with an increase of weight, but only to the extent of $\frac{1}{163}$ of the whole mass. Mr. Phillips[o] has taken the same view of the subject. I have some arsenious acid which has remained transparent for more than two years, in a glass tube hermetically sealed. This fact is confirmatory of the opinion just stated[p].

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[f] Mr. J. Taylor, *Ann. Phil.* N. S. iii. 452.

[g] *Quart. Min. Rev.* vol. ii. p. 88; and Mr. Davies Gilbert, *Paroch. Hist. of Cornwall*, iii. 305.

[h] Henwood, in *the Seventh Annual Report of the Royal Cornwall Polytechnic Society.* Falmouth, 1839. Part of the above information was obligingly communicated to me, *vivâ voce*, by Mr. Henwood.

[i] For this and some other information, as well as for samples of the rough arsenious acid from Wheal Vor tin mine, I am indebted to Mr. Ferris, surgeon, of Truro.

[j] *Transactions of the Royal Geological Society of Cornwall*, iii. 360.

Professor Guibourt[q], Mr. Phillips, and Mr. Taylor, have each found the density of the opaque variety to be less than that of the transparent. *Transparent* arsenious acid has a sp. gr. of 3·7391, according to Guibourt (3·715, Phillips; 3·208 to 3·333, Mitchell and Durand; 3·798, Taylor). It dissolves, according to the same authority, in 103 parts of water at 59°, or in 9·33 parts of boiling water, and the solution feebly reddens litmus. *Opaque* arsenious acid, on the other hand, according to Guibourt, has a sp. gr. of 3·695 (3·529, Taylor; 3·620, Phillips), is soluble in 80 parts of water at 59°, or in 7·72 parts of boiling water, and the solution restores the blue colour of reddened litmus: but I find both kinds redden litmus, and Dr. Christison has observed the same. Mr. Taylor[r] did not find any difference in the solubility of the two varieties. He found that water boiled for an hour on this substance, dissolved $\frac{1}{24}$ of its weight; that this water, on perfect cooling, did not retain more than $\frac{1}{40}$ of its weight; and that water at ordinary temperatures will dissolve from about $\frac{1}{1000}$ to $\frac{1}{500}$ of its weight. It appears, then, that water perfectly cooled from a boiling saturated solution will retain from ten to twenty or more times the quantity of acid in solution than it will take up at common temperatures without heat,—a fact which is as curious as it is inexplicable[s]. Arsenious acid is soluble in alcohol and oils. It is of importance to know that the presence of organic matters very much impairs the solvent power of water for this acid—a circumstance which readily explains why arsenious acid has not, in some cases, been found in the liquid contents of the stomach of persons poisoned by it. Arsenious acid has little or no taste, as Plenck[t], Addison, and Christison, have remarked: and neither in the solid nor vaporous form has it odour. The acid may be readily obtained in a crystalline condition by sublimation, or by cooling a boiling saturated solution: the crystals are transparent, usually regular octohedra, sometimes tetrahedra or acicular. At a temperature of 380° F. it volatilizes: when heated under pressure it liquefies, and is converted into a transparent glass.

Characteristics.—These may be conveniently and usefully discussed under three heads :—α. The characteristics of solid arsenious acid ;—β. the characteristics of a pure solution of arsenious acid ;—γ. the characteristics of arsenious acid in organic mixtures.

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[n] *Kastn. Arch.* ii. 473, quoted in Gmelin's *Handb. d. Chem.*

[o] *Transl. of the Pharm.* 4th ed.

[p] In the first edition of this work I stated that arsenious acid became opaque in an air-tight vessel. I have since had reason to believe that the bottle referred to was not completely air-tight, though covered by a varnished bladder.

[q] *Journal de Chimie Méd.* t ii. p. 57. Paris, 1826.

[r] *Guy's Hospital Reports,* vol. ii. p. 83.

[s] *Op. cit.* p. 96.

[t] *Toxicologia,* ed. 2$^{\text{nda}}$, 26.

α. **Of Solid Arsenious Acid.**—The characteristics of solid arsenious acid are (besides its physical properties before mentioned), principally three,—its volatility, the garlic odour evolved by throwing it on ignited charcoal or cinder, and the qualities of the metallic crust obtained by reducing the acid.

1. *Its volatility.*—Heated on the point of a penknife in the flame of a spirit-lamp, arsenious acid produces a white smoke, and speedily disappears. If the acid be heated in a test tube, a crystalline sublimate is obtained : the crystals are sparkling, and, when examined by a magnifying glass, are found to be regular octohedra.

The *impediments* to the operation of this test are alkaline or earthy bases which retain a portion of the arsenious acid, and prevent its rising in vapour : boracic acid may be used to counteract their influence.

The *fallacy* of this test, is, that other white solids (as hydrochlorate of ammonia, oxalic acid, &c.) are volatile, and produce a white smoke when heated.

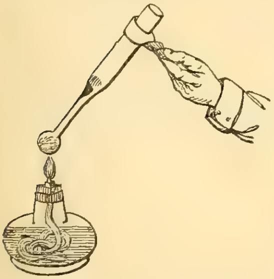
2. *Garlic odour.*—If arsenious acid, or an arsenite, be put on a piece of red-hot cinder or charcoal (placed for convenience in a saucer), it evolves a scarcely visible vapour (*metallic arsenicum*), having a garlic odour, and which, at the distance of an inch or two from the cinder, is converted into a dense, white, odourless smoke (*arsenious acid*). The deoxidation of the acid is essential to the production of the garlic odour : hence no odour is perceived when arsenious acid is placed on a heated metallic or glass plate.

The *impediment* to the action of this test is the presence of organic matter (as flour) : this, by burning, developes a strong odour, which masks the smell of the vapour of arsenicum.

The *fallacy* attending it is, that some other bodies (as phosphorus, with certain of its compounds and some organic matters) evolve when heated a garlic odour. Vauquelin, Barruel, and Orfila, have shown that a compound of albumen and fat, which exhaled this odour when heated, did not contain a particle of arsenious acid. " It is true," say these experimenters, " that arsenicum does evolve a garlic odour when volatilized ; but even when this is well characterized, it is insufficient to establish the existence of the oxide of arsenic, since it belongs to some other substances ; and it is not impossible that there may be developed in the stomach, during digestion, substances which exhale an analogous odour, when heated."

3. *Formation of a metallic crust. Reduction test.*—If arsenious acid be intimately mixed with freshly-ignited but cold charcoal, and heated in a glass tube, the acid is deoxidized, and yields arsenicum, which is sublimed into a cooler portion of the tube, where it condenses, and forms a metallic crust. A common cylindrical test tube answers very well, but the reduction tube of Berzelius (fig. 110) is to be preferred. The characters of the arsenical crust are—the brilliancy of its outer suface, which is frequently equal to polished steel or looking-

Fig. 110.



Berzelius's reduction tube.

glass; the crystalline appearance and greyish-white colour of its inner surface; its volatility; its conversion, by sublimation, up and down the tube, into octohedral crystals of arsenious acid, which may be dissolved in distilled water, and tested by the liquid re-agents presently to be mentioned; and its yielding arsenic acid by dissolving it in nitro-hydrochloric acid, and carefully evaporating the solution to dryness. The arsenic acid is known by the red precipitate *(arseniate of silver)* produced on the addition of nitrate of silver: but if the evaporation has not been carried on sufficiently far, some hydrochloric acid or chlorine will be left, which will form a white precipitate (*chloride of silver*) with nitrate of silver. The arseniate of silver may be reduced, if necessary, by mixing it with charcoal and boracic acid, and heating it in a glass tube.

In some cases the metallic crust is imperfectly formed, or is masked by some decomposed organic matter. Whenever any doubt respecting its nature is entertained, proceed as follows:—Cut off with a file the portion of the tube which contains the suspected crust, roughly powder it, introduce it into another glass tube, and apply heat. The metallic character of the crust is sometimes rendered more evident by applying to it, for a few seconds, the flame of the spirit-lamp, which drives off a black powder (*black oxide of arsenic*) and leaves the brilliant metal. If the heat be continued too long the metal itself sublimes.

The *fallacies* to which this test is liable are principally two—a charcoal crust may, by an inexperienced experimenter, be mistaken for the arsenical crust; and I have seen students confound a stratum of globules of mercury (obtained by reducing calomel) with the arsenical crust. Careful examination, especially by a magnifying glass, will, however, easily enable the experimenter to distinguish them: the inner surface of the charcoal crust is brown, powdery, and dull, whereas that of the arsenical crust has a crystalline texture, iron-grey colour, and shiny appearance: the sublimate obtained by reducing calomel or mercurial compounds has all the brilliancy of arsenicum, but by a glass is found to consist of minute globules which may be made to coalesce by the point of a knife. Lastly, the arsenical may be distinguished from all other crusts by oxidating it, as before directed, and converting it into arsenious or arsenic acid, which can be readily recognised by the tests already mentioned:—*a proceeding which ought never to be omitted.*

As a deoxidizing agent I have directed freshly ignited charcoal to be employed to convert arsenious acid into arsenicum. If carbonate of soda or of potash be mixed with the charcoal, a part only of the arsenicum is disengaged, an arseniuret of sodium or of potassium being formed: hence, when the quantity of acid to be reduced is small, charcoal only should be employed. "Where the quantity of material, however, is considerable, it is preferable to employ the black flux, or still better, as not being deliquescent, a mixture of charcoal and carbonate of soda, deprived of water of crystallization by heat[u]." If the substance to be reduced be an arsenite (as of silver, copper, or lime), or an arseniate (as of silver), a mixture of charcoal and boracic acid should be used. For the reduction of the arsenical sulphurets (as the precipitate obtained by passing hydrosulphuric acid gas through a solution of arsenious acid) a mixture of two parts of ignited carbonate of soda and one of charcoal should be employed. The alkali is here essential, in order to combine with the sulphur. Black flux (see p. 517 and 525) is objectionable on account of its deliquescent property. Various other deoxidizing agents have been recommended; as formate of soda by Goebel[v], oxalate of lime by Du Menil[w], and oxalate of soda by Dr. M'Gregor[ww]. I find that quadroxalate of potash (see p. 344) answers very well. None of these, however, present any advantage over charcoal save that of not soiling the tube (an occurrence easily avoided by using a glass funnel, as recommended by Dr. Christison, or which may be obviated by wiping the tube, after the introduction of the mixture, with a wisp of paper or feather), while their comparative scarcity and greater cost are objections to their employment. (For further details concerning the reduction process, consult Dr. Christison's *Treatise*, so frequently referred to.)

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[u] Christison's *Treatise on Poisons*, 3d ed. 237.

[v] Griffin's *Chem. Recreat.* 8th ed. 140.

[w] *Hand. d. Reag. u. Zerlegungslehre,* ii. 268. Lemgo, 1836.

[ww] *Lond. Med. Gaz.* xxii. 613.

β. **Characters of a pure Aqueous Solution of Arsenious Acid.**—A clear watery solution of white arsenic may be recognised by certain liquid re-agents which give rise to peculiar precipitates, as well as by nascent hydrogen, which causes the formation of a gas (*arseniuretted hydrogen*) possessed of remarkable and peculiar properties. The liquid re-agents, which deserve notice, are four only—namely, *lime water*, *ammoniaco-sulphate of copper*, *ammoniaco-nitrate of silver*, and *hydrosulphuric acid*. Their relative delicacy, as stated by Devergie[x], and the delicacy of the nascent hydrogen test, as ascertained by Mohr[y], and by the Commissioners[z] of the French Academy of Sciences, are as follows:—

	Dilution of arsenious solution.	
Lime water ceases to act at	2·000	
Ammoniaco-sulphate of copper, ditto at	5·200	
Hydrosulphuric acid, ditto at	200·000	
Ammoniaco-nitrate of silver, ditto at	400·000	
Marsh's nascent hydrogen test, ditto at	500·000	according to Mohr.
Ditto ditto ditto at	1000·000	according to the Commissioners.

1. *Lime Water.*—Lime water occasions a white precipitate (*arsenite of lime*), with a solution of arsenious acid. The precipitate is soluble in most acids.

The *impediments* to the operation of this test are, a large quantity of water and free acids, which hold it in solution, and gelatinous and oleaginous liquids, which keep it suspended.

The *fallacies* of this test are, carbonates, oxalates, tartrates, &c. which also throw down white precipitates with lime water. On the whole, it is a test of very little value.

2. *Ammoniaco-sulphate of Copper.*—If a dilute solution of ammoniaco-sulphate of copper be added to a solution of arsenious acid, a pale green precipitate (*arsenite of copper*, or *Scheele's green*) is obtained, and sulphate of ammonia remains in solution. This test is prepared as follows:—Add (cautiously) liquor ammoniæ to a solution of the sulphate of copper, so as to re-dissolve the oxide of copper, which it at first throws down. Care must be taken not to employ too much alkali, otherwise the test will not act. Moreover, the solution must not be concentrated, or no precipitate will be obtained.

The *impediments* to the action of this test are astringents, as tea, infusion of galls, &c. which prevent its acting characteristically.

The *fallacies* to be guarded against are, yellow-coloured and other organic fluids, which give a green colour, and slight precipitate, even though no arsenic be present.

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[x] *Méd. Lég.* ii. 718.

[y] *Journ. de Pharm.* xxiii. 566.

[z] MM. Thénard, Dumas, Boussingault, and Regnault.

3. *Ammoniaco-nitrate of silver: Hume's test.*—If a solution of ammoniaco-nitrate of silver be added to a solution of arsenious acid, a yellow precipitate (*arsenite of silver*) takes place, and nitrate of ammonia remains in solution. The precipitate is soluble in liquid nitric acid, solution of ammonia, and a solution of nitrate of ammonia. The mode of preparing this test is as follows:—Add a few drops of liquor ammoniæ to a solution of nitrate of silver, so that the oxide of silver which the alkali at first throws down may be nearly, but not entirely, redissolved (see *Solutio Argenti Ammoniati*, E.). Great care is requisite to add neither too much nor too little; for if too much be employed, the solution will not occasion any precipitate with arsenious acid; and if too little, it will produce a precipitate with phosphate of soda similar in colour to that produced with arsenious acid. The only certain way of knowing when the proper quantity has been employed is to test it. Arsenious acid, but not phosphate of soda, ought to occasion a precipitate with it.

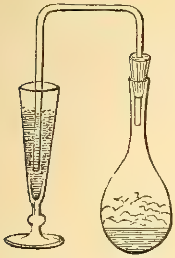
The *impediments* to the operation of this test, are, free acids (as hydrochloric, nitric, acetic, citric, or tartaric), chlorides, and organic matters. The acids may be readily neutralized by an alkali. If common salt, or other metallic chloride, be present, ammoniaco-nitrate of silver throws down a white precipitate (*chloride of silver*), even though a considerable quantity of arsenic be present. To obviate this, add a few drops of nitric acid, then an excess of a solution of nitrate of silver. Filter to get rid of the precipitated chloride of silver, and apply the ammoniaco-nitrate of silver. The presence of much organic matter impedes the action of this test.

Ammoniaco-nitrate of silver, when properly prepared, does not occasion a yellow precipitate with any substance save arsenious acid; and hence is not subject to any *fallacy* of that kind. If, however, it be not properly prepared, it may occasion a yellow precipitate (*subsesquiphosphate of silver*) with phosphate of soda. There is an optical fallacy, against which the student should be put on his guard: if ammoniaco-nitrate of silver be added to certain yellow liquids containing common salt, a white precipitate (*chloride of silver*) is produced, which, seen through a yellow medium, might, by a careless observer, be mistaken for a yellow precipitate.

4. *Hydrosulphuric Acid* (*Sulphuretted Hydrogen*).—If this gas be passed through a solution of arsenious acid, a yellow precipitate (*sesquisulphuret of arsenicum* or *orpiment*) is produced, while the oxygen of the arsenious acid, and the hydrogen of the hydrosulphuric acid, unite to form water. In order, however, for this effect to be produced, it is necessary that the liquid be slightly acidified by some acid (as the hydrochloric). If the liquid be already acid, we must neutralize it by cautiously adding an alkali, and then acidify by hydrochloric acid.

In applying this test we may place the suspected liquid in a test-tube, or conical wine or ale-glass (fig. 111); the gas being developed in a common Florence flask (or two-necked bottle, as recommended by Dr. Christison): the mouth of the flask is closed by a cork, perforated by a tube curved twice at right angles. The gas should, if possible, be passed through water contained in a double-necked bottle, before it is conveyed into the arsenical liquor, as a portion of iron is apt to be carried over. The ingredients for developing the gas are a metallic sulphuret (as of iron or antimony) and sulphuric or hydrochloric acid. I prefer the sulphuret of iron with sulphuric acid diluted with water. These are to be introduced into the flask previous to the adaptation of the cork. After the gas has passed through the arsenical liquid for a few minutes, portions of the yellow sesquisulphuret of arsenicum (*orpiment*) begin to fall down. The separation of the precipitate is promoted by ebullition, and the exposure of the solution for a few hours to the air. The essential characters of the precipitate are, its yellow colour, its rapid solution in liquor ammoniæ, forming a colourless and very limpid liquid, and its yielding metallic arsenicum when dried and heated with black flux, or a mixture of ignited carbonate of soda and charcoal. When the quantity of sesquisulphuret is small, some difficulty may be experienced in removing it from the filter for reduction. The readiest way is that recommended by Devergie:—Collect it on the filter in as small a space as possible, then wash it with liquor ammoniæ, which dissolves it. The filtered liquid may then be evaporated in a capsule or watch-glass: the ammonia flies off, and leaves the sesquisulphuret.

Fig. 111.



Mode of passing Hydrosulphuric Acid through an arsenical solution.

The *fallacies* of the hydrosulphuric acid test are, the *salts of cadmium*, the *persalts of tin*, the *antimonial compounds*, and *selenic acid*, which occasion precipitates with hydrosulphuric acid, more or less analogous in colour to that produced by arsenious acid. The precipitate with cadmium closely resembles that with arsenic, but it is not soluble in alkaline solutions. This metal (cadmium) has been detected in some of the preparations of zinc[a]. The perchloride of tin, sold for the use of dyers under the name of *spirit of tin*, occasions a yellow precipitate *(bisulphuret of tin)* somewhat resembling sesquisulphuret of arsenicum. Very weak solutions of emetic tartar form a reddish-yellow liquid, or throw down a reddish precipitate *(hydrated sesquisulphuret of antimony)* somewhat analogous in appearance to that formed by an arsenical liquid. If hydrosulphuric acid be transmitted through a liquid in which *pulvis antimonialis* has been boiled, the solution acquires a yellowish-red colour, from the formation of some sesqui- or bisulphuret of antimony. From all the above precipitates sesquisulphuret of arsenicum is readily distinguished by the reduction test already mentioned.

Hydrosulphate of ammonia (described at p. 478) is sometimes employed as a substitute for hydrosulphuric acid, an acid being added at the time of applying it, to neutralize the ammonia; but it is liable to several serious objections. When fresh prepared it causes a yellowish precipitate with arsenious acid, red with emetic tartar, and black with solutions of lead; but by exposure to the air for a day or two, it forms a white precipitate with arsenious acid, yellow with emetic tartar, and red with lead!

5. *Nascent Hydrogen: Marsh's test.*—If arsenious acid be submitted to the action of nascent hydrogen, it is deoxidized, and the metallic arsenicum thereby obtained, combining with hydrogen, forms arseniuretted hydrogen gas.

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[a] *Vide* Thomson's *History of Chemistry*, ii. 220.

This test, which is the discovery of Mr. Marsh, of Woolwich[b], may be thus applied:—Mix a small portion of the suspected liquid with some diluted sulphuric acid (1 oil of vitriol and 7 water), and pour the mixture over some pieces of zinc previously introduced into a proper apparatus: bubbles of gas immediately make their appearance. If no arsenious acid be present, the evolved gas is hydrogen; but if the liquor hold arsenic in solution, arseniuretted hydrogen gas is formed. This gas is recognised by the following characters:—

α. It has an alliaceous odour.

β. It burns with a bluish white flame and the evolution of a whitish smoke. If a plate of mica (commonly termed talc) or of common window glass, or of porcelain (as a white saucer or dinner plate), be held a short distance above the flame, arsenious acid in a finely pulverulent state is deposited on it, forming a white crust: if the plate be depressed so as to cut the flame, and thereby slightly to impede the combustion of the gas, a blackish deposit *(metallic arsenicum)* is obtained. Or both these deposits may be readily and simultaneously procured by holding vertically over the flame a tube of glass, nine or ten inches long, and a quarter or half an inch in diameter: the tube becomes lined for the space of several inches with metallic arsenicum and arsenious acid, and the garlic odour can be detected at either end of the tube. To obtain solutions of the acid, let the flame successively play beneath three or four drops of water placed on the under side of a plate of mica; then apply the liquid tests for arsenic before mentioned[c]. Or apply separate drops of the liquid tests themselves to the plate, and then let the flame play on them successively for a few minutes, the characteristic effects of arsenious acid will be obtained. Care must be taken not to apply a lighted taper to the jet of gas before the air is expelled, or an explosion may be the result.

Various forms of apparatus may be used for this experiment. That employed by Mr. Marsh is a simple glass tube, bent like a syphon (fig. 112). A bit of glass rod is dropped into the shorter leg, then a piece of clean sheet zinc: the stop-cock and jet are afterwards to be inserted. The suspected liquid, mixed with the dilute acid before mentioned, is to be then poured into the long leg. Effervescence is then produced, and after allowing the air to be expelled, the stop-cock is to be closed, and when a sufficient accumulation of gas has taken place, it is again to be opened, and the gas ignited. Where the matter to be examined is very small in quantity, Mr. Marsh puts the suspected liquid, the acid, and the zinc, in a little glass bucket (fig. 113), attached to the stop-cock by a platinum wire, and then introduces it into the short leg of the syphon, previously filled with common water.

When the quantity of arsenical liquor to be tested is large, an inverted bell-glass with a stopcock attached may be used. The zinc is suspended within. The bell glass is immersed in the diluted acid to which the suspected liquor is added. This apparatus is similar to that used for obtaining fire by the aid of a stream of hydrogen gas thrown on spongy platinum.

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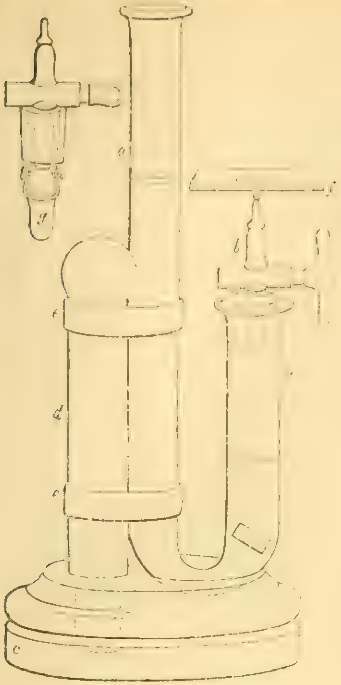
[b] *Trans. of the Soc. of Arts*, li. 66; also *Lond. Med. Gaz.* xviii. 650.

[c] Herapath, *Lond. Med. Gaz.* vol. xviii. p. 889.

FIG. 113. FIG. 112.



Marsh's Apparatus.

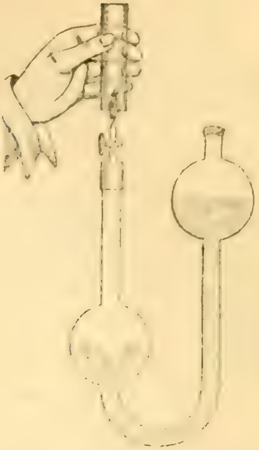
FIG. 112.

a. A syphon tube.
b. Stop-cock.
c. Wooden block.
d. The pillar.
e, e. Caoutchouc slips, to fasten the tube to the pillar.
f. Plate of mica or glass.

FIG. 113.

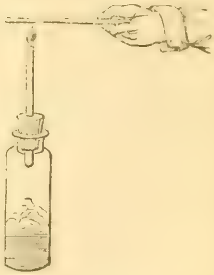
g. Small glass bucket.

FIG. 114.



Modification of Marsh's Apparatus.

FIG. 115.

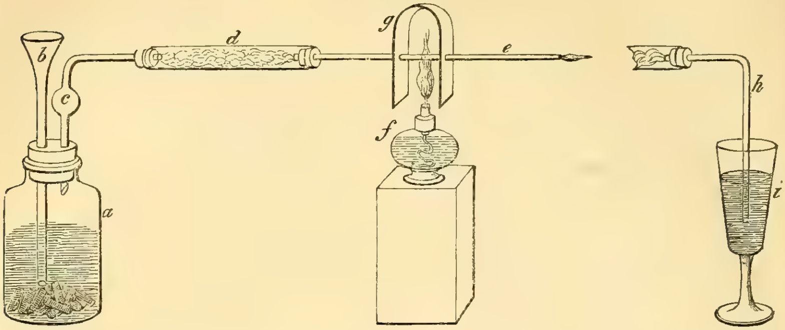


Simple mode of applying Marsh's Test.

A modification (fig. 114) of Mr. Marsh's apparatus is supplied with two bulbs, one in each leg of the instrument, and presents some advantages over the simple syphon tube: thus it enables us to collect a larger quantity of gas, while the bulb assists in checking the frothing by breaking the bubbles. But the simplest, cheapest, and often the most useful form of apparatus, is a two-ounce wide-mouthed phial, with a cork perforated by a glass tube or tobacco-pipe (as in fig. 115). It presents this great advantage, that we can employ a fresh apparatus for every experiment, and thus avoid all possibility of contamination from arsenical liquids used in previous experiments.

γ. If arseniuretted hydrogen be subjected to a red heat it is decomposed into arsenicum, which is deposited, and hydrogen gas, which escapes. The gas may be generated in a double-necked bottle, or in a wide-mouthed bottle, closed by a cork bored with two holes; and may be allowed to escape by a horizontal tube (made of difficultly fusible glass), which may be heated by a large-wicked spirit lamp. The gas is decomposed by the heat; and the arsenicum is deposited in the form of a metallic ring, beyond the flame and nearer the aperture.

FIG. 116.



Apparatus for subjecting Arseniuretted Hydrogen to the action of Heat or Nitrate of Silver.

a. Bottle for generating the arseniuretted hydrogen.
b. Funnel, or tube, by which the sulphuric acid and arsenical liquor are introduced into the bottle.
c. Escape tube, supplied with a bulb, to condense any liquid which may rise from the bottle.
d. Wider tube, loosely filled with asbestos, to impede the passage of any water. This is not essential.
e. Narrow tube of difficultly fusible glass, drawn out to a fine point at the extremity.
f. Spirit lamp.
g. Curved and perforated metallic plate (copper, zinc, or tinned iron), to support the glass-tube in the event of its softening by the heat.
h. Curved glass-tube, which may be substituted for the tube *e*, when the gas is to be passed through a solution of nitrate of silver.
i. Test-glass, containing a solution of nitrate of silver.

The detection of arseniuretted hydrogen by heat was suggested by Liebig[d], Berzelius[e], and Chevallier[f]. Some useful and practical improvements in the mode of applying this test were suggested by MM. Kœppelin and Kampmann[g]. The Commissioners appointed by the French Academy introduced some additional modifications of the experiment[h]. The latter recommend that the tube *e* should be coated with gold or silver leaf, and subjected to the heat of a coal fire, which is preferred to the spirit-lamp flame, as it more effectually decomposes the gas. But it complicates the operation, and renders it much more difficult of performance.

The arsenicum deposited in the tube may be recognized by its physical and chemical properties before described (see p. 625).

If the arseniuretted hydrogen be completely decomposed, hydrogen only will be evolved by the extremity of the tube *e*. But as a portion of gas may escape decomposition, the jet should be set fire to, and attempts made to obtain arsenical spots on a plate of porcelain.

δ. If the arseniuretted hydrogen be passed through a solution of nitrate of silver, a mutual re-action between these substances is effected. Black metallic flocculi are deposited, and a solution of arsenious acid is obtained, mixed with free nitric acid. Hydrochloric acid is then to be cautiously added to the decanted liquor, to convert the excess of nitrate of silver into the insoluble white chloride of silver. The filtered liquor may then be tested for arsenious acid. Or it may be evaporated to dryness, during which operation the nitric acid oxidizes the arsenious acid, and converts it into arsenic acid, which constitutes the dry residuum. This yields a brick-red precipitate, with a solution of nitrate of silver. Or the concentrated solution may be tranferred to a very small Marsh's apparatus.

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[d] *Journal de Pharmacie*, t. xxiii. p 568.
[e] *Ibid.* t. xxiv. p. 180.
[f] *Journ. de Chim. Méd.* t. v. IIe Sér. p. 380.
[g] *Journ. de Pharmacie*, t. xxvii. p. 408; *Lond. Med. Gaz.* Aug. 20, 1841.
[h] *Ibid.* t. xxvii. p. 425.

This test was suggested by Lassaigne[i]. It has been adopted by the Commissioners appointed by the French Academy[j]. It is a very valuable mode of using Marsh's test, and prevents the loss of the first portions of gas.

The apparatus fitted for performing Lassaigne's test has been already described and figured (see p. 432, fig. 116, *h*).

The black flocculi produced in a solution of nitrate of silver by arseniuretted hydrogen are regarded by Lassaigne as metallic silver, by Graham[k] as arseniuret of silver. It appears to me to be metallic silver contaminated by some intimately adherent arsenious acid, which can be removed by repeated washing and boiling in water, and especially by washing with an alkaline solution.

In the performance of Marsh's test there are several impediments and fallacies, with which the student should be acquainted.

α. The *impediments* to the operation of Marsh's test are, organic liquids (as porter, soup, contents of the stomach, &c.), which occasion great frothing, and choke up the jet. To obviate these, various methods have been advised; such as greasing or oiling the interior of the short leg of the apparatus; putting a layer of alcohol or oil on the surface of the liquid in the short limb, and placing the apparatus aside for an hour or two, to allow the bubbles to burst. These methods are all more or less objectionable. They either imperfectly fulfil the object intended, or they mask somewhat the qualities of the arseniuretted hydrogen. The best mode of proceeding is to evaporate the arsenical liquor to dryness, and char it either by heat, very cautiously applied, or by means of oil of vitriol. Danger and Flandin[l] give the following directions for its execution:—Add to the organic matter contained in a porcelain capsule, $\frac{1}{6}$ of its weight of sulphuric acid, and heat until vapours of sulphuric acid appear. The matter is first dissolved, but during the concentration it is charred. The liquor is to be constantly stirred with a glass rod. The carbonization is effected without any swelling or frothing, and is to be continued until the charcoal is friable and almost dry. A small quantity of concentrated nitric acid or nitro-muriatic acid is to be added, by means of a pipette, when the capsule is cold. This converts the arsenious acid into the more soluble arsenic acid. The mixture is then to be evaporated to dryness, treated with boiling water, and the limpid liquor introduced into Marsh's apparatus, in which it never froths.

Nitric acid or nitrate of potash is sometimes used to char organic matter; but it is less manageable than sulphuric acid; for towards the end of the experiment it is difficult to prevent deflagration, by which part of the arsenic is lost.

β. The *fallacies* of this test arise from the presence of either antimony or imperfectly charred organic matter in the suspected liquid, or from the employment of either zinc or sulphuric acid contaminated with arsenic. A solution of Emetic Tartar, placed in Marsh's apparatus (with zinc and dilute sulphuric acid) evolves *antimoniuretted hydrogen gas*, which agrees in several of its characters with arseniuretted hydrogen[m]. Thus it has a marked odour (dependent probably on the hydrogen), and which might be confounded with that of arseniuretted hydrogen. It burns in the air with a yellowish flame, and the deposition of a black crust of metallic antimony surrounded by a white one of oxide (on mica or glass held over it), resembling arsenicum and arsenious acid deposited by arseniuretted hydrogen: moreover, the action of hydrosulphuric acid and of ammoniaco-sulphate of copper on the oxide of antimony, produces colours similar to those generated by the action of these tests on arsenious acid. Furthermore, when heated during its passage through a glass tube, antimoniuretted hydrogen is decomposed, and forms a dark metallic crust. It also occasions a black deposit in a solution of nitrate of silver. The antimonial, may be distinguished from the arsenical, crust by adding a drop of nitric acid, and evaporating to dryness: a white powder is left in each instance. A few drops of a dilute solution of the nitrate of silver being now added, and the whole exposed to the fumes arising from a stopper moistened with ammonia, the arsenical crust will give the well-known canary-yellow flocculi[n]. Moreover, the greater volatility of arsenicum, and its conversion into octohedral crystals of arsenious acid[o], may serve, in some cases, to distinguish it from antimony. Furthermore, the solubility of the arsenious acid, and the reaction of the before-mentioned liquid tests on the solution, will distinguish it from oxide of antimony, which is insoluble. If antimoniuretted hydrogen be conveyed into a solution of nitrate of silver, no arsenious or arsenic acid can be detected by the tests before directed to be used for arseniuretted hydrogen. Lastly, the metallic crust obtained by submitting a current of the gas to heat presents some distinguishing characters: the arsenical crust is always deposited in the more distant or anterior part of the tube, whereas the antimonial one is first deposited on the heated part of the tube, and by continuing the heat we obtain two rings, one in the anterior or more distant, the other in the posterior or less distant part of the tube.

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[i] *Journal de Chimie Méd.* t. vii. II^{e} Sér. p. 638.

[j] *Journal de Pharmacie*, t. xxvii. p. 425.—Also, *Lond. Med. Gaz.* Aug. 20, 1841.

[k] *Elements of Chemistry*, p. 635.

[l] *Journal de Pharmacie*, t. xxvii. p. 411-412.

[m] Mr. L. Thompson, *Lond. and Edinb. Phil. Mag.* May 1837.—Also Pfaff, *Pharmaceutisches Central-Blatt für* 1838, S. 65.

In performing Marsh's test great care must be taken that the apparatus be perfectly clean, and that fresh zinc and acid liquor be used for every experiment. It has been already stated (p. 470) that sulphuric acid frequently contains arsenious acid. The experimenter should also be fully alive to the possibility of the zinc, or even the brasswork of the apparatus, containing minute traces of arsenic; hence the necessity of examining the qualities of the hydrogen flame before adding the suspected arsenical liquid. It has been shown by Mohr[p] that zinc which had been once used, but afterwards carefully washed both in water and acid, retained sufficient arsenic to produce the usual effects on the hydrogen flame.

Messrs. Danger and Flandin[q] have asserted, and their statements are confirmed by the report of the commissioners of the French Academy[r], that imperfectly carbonized organic matter introduced into Marsh's apparatus may deposit on glass or porcelain crusts which strongly simulate those obtained from arsenical substances. These non-arsenical spots are composed of sulphite and phosphite of ammonia mixed with a small quantity of organic matter. They dissolve with difficulty in nitric acid, and the residue, obtained by evaporating the nitric solution to dryness, yields, on the addition of nitrate of silver, a yellow precipitate of phosphate of silver. The true arsenical spots, on the other hand, dissolve readily in nitric acid, and the residue obtained by evaporating the nitric solution to dryness forms, with nitrate of silver, a brick-red precipitate of arseniate of silver.

γ. **Detection of Arsenious Acid in Organic Mixtures.**—I shall confine myself to a brief notice of the modes of detecting arsenious acid when mixed with the contents and tissues of the stomach, and must refer the reader to the works of Dr. Christison[s] and Devergie[t] for further details, especially in reference to other organic mixtures.

When the stomach is laid open we sometimes observe in it a white powder or white particles; these are, of course, to be carefully removed; and if they be arsenious acid, no difficulty will be experienced in recognising them by the tests already mentioned (p. 625).

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[n] Mr. L. Thompson, *op. cit.*
[o] Dr. E. Turner's *Chemistry*, by W. Turner.
[p] *Journ. de Pharm.* xxiii. 563.
[q] *Journal de Pharmacie*, t. xxvii. p. 410.
[r] *Ibid.* p. 428.
[s] *Treatise on Poisons;* also *Edinb. Med. and Surg. Journ.* xxii. 60.
[t] *Médécine Légale*, ii. 718.

If no solid arsenious acid be observed, cut the stomach into small pieces, and boil it with the contents of this viscus for half an hour in distilled water, to which a small quantity of liquor potassæ has been added: then filter, first through muslin, and afterwards through paper. Fibrin is insoluble in water, and, by boiling, albumen is coagulated, so that (with the exception of small portions of these principles held in solution by the alkali) the filtered liquor is free from both fibrin and albumen. A little acetic acid is now to be added, and the liquid boiled, by which any caseum present will be coagulated, and got rid of by filtering a second time. Sometimes the liquor is now found sufficiently free from organic matters to enable us to detect the arsenious acid very readily by the ammoniaco-nitrate of silver. Dr. Christison says, that if this test act characteristically, that is, gives a copious yellow precipitate, the liquid is sufficiently free from foreign matter. If, however, it give no indication, or at least only imperfect ones, of arsenious acid, evaporate to dryness by a gentle heat (as a water-bath), and boil the residue in repeated portions of distilled water. We thus obtain a solution of arsenious acid, which, after being acidulated with acetic or hydrochloric acid, is to be decomposed by passing a current of hydrosulphuric acid through it. The precipitated orpiment (*sesquisulphuret of arsenicum*) is to be collected, and reduced in the way already described (pp. 625 and 629).

Arsenious acid in organic liquids may sometimes be readily detected by the development of arseniuretted hydrogen when zinc and sulphuric acid are added to the suspected liquor (*vide* p. 630), but the frothing produced by the organic matter creates considerable difficulty. I have already pointed out the best method of obviating this (see p. 633).

COMPOSITION.—The following is the composition of arsenious acid:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Mitscherlich.*
Arsenicum....	1	38	76	75·782	75·73
Oxygen	1½	12	24	24·218	24·27
Arsenious Acid	1	50	100	100·000	100·00

PURITY.—Powdered arsenious acid is sometimes adulterated with chalk or sulphate of lime. The fraud is readily detected by heat, which volatilizes the acid, but leaves the impurities.

It is entirely sublimed when heated. Mixed with charcoal and exposed to heat, it emits an alliaceous smell. It is dissolved by boiling water; and hydrosulphuric, when added, throws down a yellow precipitate, and lime-water yields a white one. *Ph. L.*

The *Edinburgh College* merely observes, that arsenious acid "is entirely sublimed by heat."

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—The effects of arsenious acid on plants have been studied by Jäger[u], Marcet, Macaire[v], and by others, and from their observations we learn that it is poisonous to all the higher, and most of the lower, families of plants. It appears that seeds which have been soaked in a solution of arsenious acid are incapable of germinating, and that buds which have been plunged in it are no longer capable of expanding. If roots or stems be immersed in this solution the plants perish: death being preceded by drooping of the leaves and petals, and the appearance of brownish patches on the leaves, the veins and midribs of which are discoloured. If the stem of the Common Barberry (*Barberis vulgaris*) be placed in a solution of arsenious acid, the plant dies, but the stamens, according to Macaire, become stiff, hard, and retracted, and on any attempts being made to alter their position, they readily break. On repeating the experiment, however, I did not observe this condition of the stamens. I found them not at all brittle, but quite flexible, and difficult to break by the point of a knife. The leaves when burnt evolved a garlic odour. Jäger has seen a small plant (supposed by De Candolle[w] to be *Mucor imperceptibilis*) growing in water which contained $\frac{1}{32}$ of its weight of arsenic. And, more recently, Gilgenkrantz[x] says he has seen an algaceous plant, of the genus either *Leptomitus* or *Hygrocrocis*, develope itself in a solution of arsenic. These are most remarkable exceptions to the general effects of this poison on vegetables, and deserve further examination. Jäger has shewn that arsenic is absorbed by plants; for he found that, on burning vegetables destroyed by this poison, he obtained a garlic odour, as I have also done.

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[u] *Diss. Inaug.* Tubingæ, 1808; quoted by Marx, in his *Die Lehre von den Giften*, ii. 99.

[v] *Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève*, t. iii.

β. On Animals generally.— Arsenious acid is poisonous to all classes of animals. No exceptions, I believe, are known to exist to this statement. The most extensive series of experiments on this subject are those performed by Jäger[y]. From them we learn, that in all animals, from the infusoria up to man, death from arsenic is invariably preceded by inordinate actions and increased evacuations, especially from the mucous membranes. In most animals the stools were frequent and fluid; and in those in which mucus is secreted on the surface, it was remarkably increased. The power of voluntary motion and susceptibility of external stimuli were decreased; and after death the muscles soon ceased to be influenced by the galvanic agency. In animals which breathe by lungs, respiration became difficult and laborious; and in warm-blooded animals great thirst was experienced. In birds and mammals convulsions came on, preceded by vomiting, except in those animals (as the rabbit) which cannot vomit (see p. 99). Enormous quantities of arsenious acid have been sometimes administered to horses with impunity. Berthe[z] gave two, and afterwards three, drachms to a mare, for the cure of an obstinate skin disease, without any injurious effects. Beissenhirz[a] gave successively, on different days, one, four, three, two, and eight drachms of arsenious acid to a horse: the animal did not die until the ninth day after taking the last-mentioned dose. Yet, notwithstanding these and some other analogous facts, which seem to prove that arsenic has comparatively little effect on horses, the best informed veterinarians agree in considering it an energetic poison to these animals[b].

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[w] *Phys. Vég.* p. 1329.
[x] *Journ. de Pharm.* xxiii. 38.
[y] *Op. cit.*
[z] *Recueil de Med. Vét.* Oct. 1825.
[a] Quoted by Wibmer, *Die Wirkung*, &c. i. 317.

γ. *On Man.* *aa. Of very small* or *therapeutical doses.*—In very small quantities (as one-sixteenth or one-twelfth of a grain) no obvious effects are usually produced by the use of arsenic, unless it be continued for a long period. Indeed some writers[c] go so far as to assert that it is a strengthening remedy, and that it improves the appetite, invigorates digestion, promotes assimilation and secretion, excites the muscular and nervous functions,—in a word, acts as a *tonic.* I cannot, however, subscribe to this doctrine. It is, indeed, true that patients sometimes experience a temporary increase of appetite from the use of small doses of arsenic; and it is also certain that this remedy is frequently beneficial in agues and other diseases in which tonics have been found efficacious. But the analogy between the action of arsenious acid and that of the vegetable tonics, as cinchona (to which Vogt compares it), stops here. I have sought in vain for other evidences of a tonic operation. I have seen very minute doses of arsenic given to patients affected with lepra, and continued for many days, without being able to detect the least indication of its action on the system, except the amelioration of the disease. When the dose was slightly increased, the appetite in some cases appeared to be increased; but the effect was neither universal nor continued. Very shortly afterwards, a sensation of heat in the throat, œsophagus, and stomach, came on, occasionally with nausea, but seldom with vomiting; in a few cases with gastrodynia; a febrile condition of the body was set up; there were dryness of the skin, increased secretion of urine, relaxed bowels, sometimes with griping; the patients usually complained of great languor, inaptitude for employment, and want of sleep; and sometimes these symptoms were accompanied with, or followed by, redness of the eyes, and certain swellings, especially of the face (*œdema arsenicalis*)—effects which are so different from those produced by the remedies called strengthening, that I cannot regard arsenic as a tonic. In proof of the beneficial effects of this substance, we are gravely told that the country-people of Upper Styria, in Austria, use arsenic as a stomachic, and condiment for many kinds of food—for example, cheese; and a healthy peasant himself tells us, that he was accustomed to take two grains of arsenic daily, without which, he assures us, he could not live[d]! In further proof of this strengthening action of arsenic, Vogt says that it promotes the appetite, the activity, and the power of old enfeebled horses, and mentions that Jäger noticed the same effects on a pigeon. To the first of these statements, namely, the beneficial effects from the use of arsenic as a condiment, I confess I do not give credence; and, with respect to the action of arsenic on horses, every well-informed veterinarian knows that it operates on these animals as a poison.

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[b] See the evidence of Mr. Bowles, in the *Ed. Med. and Surg. Journ.* viii. 351.

[c] Vogt, *Pharmakodynamik.*

[d] *Med. Jahrb. d. österr. Staates,* 1822, i. 96, quoted from Wibmer.

Dr. Fowler[e] gives the following summary of the effects of the arsenical solution in more than 320 cases:—In about one-third no operation: "somewhat more than one-third were attended with nausea; and nearly one-third with an open body; and about one-third with griping. Vomiting, purgings, swellings, and anorexia, were but rare in comparison with the preceding effects, and their less frequent occurrence was generally found in the order in which they are here enumerated, swellings and anorexia being the seldomest. About one-fifth of the cases attended with nausea, and one-quarter of those attended with an open body, were unconnected with any other effects. Griping did not often occur alone; purging and anorexia seldom or never; and vomiting was always accompanied with more or less nausea." In some cases salivation has been produced by the medicinal use of arsenic, as will be noticed presently.

β. Of long-continued small doses, or of large medicinal doses (*Slow or Chronic Poisoning*).—Small doses of arsenious acid continued for a long period, act as a slow poison; and, if persevered in, will ultimately occasion death. The same effects take place, in a shorter period, from the administration of large medicinal doses. Sometimes the digestive apparatus, at other times the nervous system, first shews symptoms of the poisonous operation of this agent.

Hahnemann (quoted by Dr. Christison) has graphically described the condition of slow poisoning by arsenic as "a gradual sinking of the powers of life, without any violent symptom; a nameless feeling of illness, failure of the strength, an aversion to food and drink, and all the other enjoyments of life."

On some occasions the first symptoms which I have observed of its poisonous operation have been thirst, redness of the conjunctiva and eyelids, followed by a cutaneous eruption. At other times irritation of the stomach is the leading symptom. In some cases ptyalism is brought on. Marcus[f] noticed this effect; as also Dr. Ferriar[g]. Mr. Furley[h] has published five illustrative cases of it. Trousseau and Pidoux[i] also mention this symptom as produced by the long-continued use of feeble doses of arsenic. Another instance of this effect has been published by Mr. Jones[j]. This effect acquired some importance in the celebrated Bristol case of poisoning[k].

The following is an abstract of the symptoms produced by the long-continued employment of small doses of arsenious acid, but which are more or less modified in different cases:—Disorder of the digestive functions, characterized by flatulence, sensation of warmth, or actual pain, in the stomach and bowels; loss of appetite; thirst, nausea, and vomiting; purging, or at least a relaxed condition of the bowels, and griping; furred tongue, with dryness and tightness of the mouth and throat, or with salivation. Quick, small, and sometimes irregular, pulse; oppressed respiration, with a dry cough. The body wastes; the stomach being frequently so irritable that no food can be retained in it. Headache, giddiness, and want of sleep, are frequently observed. The limbs become painful, feeble, trembling, subject to convulsions; occasionally benumbed, and ultimately paralyzed. The cutaneous system is, in some cases, affected, an eruption makes its appearance, and now and then the hair and nails fall off. Swelling of the feet and of the face is not unfrequently observed; and under these symptoms the patient gradually sinks, in some cases retaining his consciousness to the last, but at other times delirium or stupor supervening.

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[e] *Med. Reports of the Effects of Arsenic*, p. 98. Lond. 1786.
[f] *Ephemeriden*, 1809.
[g] *Med. Hist. and Refl.* iii. 306.
[h] *Lond. Med. Gaz.* xvi.
[i] *Traité de Thérap.* ii. 148.
[j] *Lond. Med. Gaz.* vol. xxvi. p. 266.
[k] *Ibid.* xv. 519; and *Trans. Prov. Assoc.* iii. 432.

γ. *Of excessive or poisonous doses* (*Acute Poisoning*).—The symptoms produced by the ingestion of a large dose of arsenious acid are not invariably alike, but put on three forms. In some cases the principal or leading ones are those indicating gastro-enteritis; the nervous system being not obviously, or at least only slightly, affected. In others, the gastro-enteritic symptoms are absent, and the principal operation of the poison is on the vascular and nervous systems. Lastly, there are other cases in which we have gastro-enteritic symptoms, with an affection of the nervous and vascular systems.

Form 1st: Acute poisoning with symptoms of gastro-enteritis.—In this form of arsenical poisoning, nausea and vomiting come on soon after the poison has been swallowed, and are attended with burning pain in the throat and stomach, which soon extends over the whole abdomen. Pain and vomiting, however, are not invariably present. The matters vomited vary in their nature and appearance; sometimes being bilious, at other times tinged with blood. Frequently there is a sense of heat, dryness, tightness, and constriction of the throat, accompanied with incessant thirst, and occasionally with an almost hydrophobic difficulty of swallowing. The lower part of the alimentary canal soon becomes affected, indicated by the burning pain, which is increased on pressure—by the hard and tense condition of the abdomen—by the diarrhœa (the stools occasionally being bloody)—by the tenesmus—and by the occasional heat and excoriation of the anus. When the lower part of the alimentary canal is powerfully irritated, the urino-genital apparatus becomes affected; and thus there may be difficulty in passing the water, with burning pain in the genital organs. The constitutional symptoms are, in part, such as might be expected from this violent local disorder: thus the pulse is quick, but at the same time small, feeble, and irregular: there are cold clammy sweats; the action of the heart is irregular, giving rise to palpitation; the breathing is short, laborious, and often painful; the tongue is dry and furred; and the membrane lining the air-passages feels hot, and oftentimes painful.

Although, in this form of acute arsenical poisoning, the gastro-enteritis is the principal, and, in some cases, almost the only affection, yet there are generally observed some symptoms indicative of disorder of the cerebro-spinal system: sometimes in the form of tremblings or cramps of the limbs, or delirium, and even, in the last stage, insensibility. Occasionally, also, eruptions take place.

In this form of poisoning, death usually occurs in from twenty-four hours to three days after the administration of arsenic; but Dr. Christison says that Pyl has recorded a case where death occurred in three hours after swallowing the poison.

Form 2d: Acute poisoning with narcotism, without any remarkable symptoms of gastro-enteritis.—In some cases of poisoning, in both man and animals, the symptoms are those indicating disorder of the cerebro-spinal and vascular systems: abdominal pain, vomiting, and purging, being either altogether absent or very slight.

The symptoms are usually faintness, or perhaps actual syncope, convulsions, or paralysis; and, sometimes, insensibility; at other times, delirium. These symptoms constitute the state called *narcotism.* Of this form of arsenical poisoning (which is somewhat rare) Dr. Christison has given an abstract of twelve recorded cases. In most of them the quantity of arsenious acid taken was very large; for example, half an ounce, or even an ounce.

Form 3d: Acute poisoning with symptoms of gastro-enteritis, followed by an affection of the cerebro-spinal system.—In this form of poisoning we have at first the usual gastro-enteritic symptoms, and which I have already described under the first form of poisoning. When, from the smallness of the dose, or from other circumstances, the patient recovers from the gastro-enteritis, symptoms of a cerebro-spinal affection sometimes make their appearance. The kind of disorder, however, varies considerably in different individuals. "The most formidable," says Dr. Christison, "is coma; the slightest, a peculiar imperfect palsy of the arms or legs, resembling what is occasioned by the poison of lead; and between these extremes have been observed epileptic fits, or tetanus, or an affection resembling hysteria, or madness."

In a medico-legal point of view it is important to determine *what is the smallest fatal dose of arsenious acid*[l]. It is not easy, however, to give a positive answer to this question. Dr. Christison says, "the smallest actually-fatal dose I have hitherto found recorded is 4½ grains. The subject was a child four years old, and death occurred in six hours. In this instance, however, the poison was taken in solution." The powerful effects sometimes produced by ⅛, ¼, or ½ a grain, lead us to suspect that 1 grain *might* produce death; but we have no recorded case of this. Hahnemann says, 1 or 2 grains may prove fatal in a few days; and Dr. Christison remarks, that this statement cannot be very wide of the truth. Of course a *repetition* of much smaller quantities might cause death. However, under certain circumstances, enormous quantities have been swallowed with very trivial effects. Some years ago I opened the body of a man who destroyed himself by taking arsenic, and I was informed by the friends that about a fortnight previous to his death, he made an attempt to destroy himself by swallowing a quantity of powdered arsenic, which they found, on inquiry at the druggist's of whom it was purchased, to have weighed half an ounce. It was taken immediately after dinner, and the only effect produced was violent vomiting. Here it is evident that the distension of the stomach with food saved the patient's life. This unfortunate individual repeated the attempt, and death was the result. Another remarkable case of recovery, after the ingestion of half an ounce, has been recorded by Dr. Skillman[m].

MORBID APPEARANCES PRODUCED BY ARSENIOUS ACID.—When arsenious acid kills by its narcotic operation (constituting the second form of arsenical poisoning), no morbid condition is observable after death. In other cases, however, various alterations are observed, which may be most conveniently arranged under the following heads:—

a. Morbid appearances of the alimentary canal.—The alterations observed in the condition of the intestinal canal vary with the quantity of the poison taken, and probably with other circumstances, but they are all indicative of inflammation: thus we have redness as one symptom, sometimes accompanied with extravasations of blood into the tissue of the canal; ulceration is also frequently observed, sometimes softening of the mucous coat, effusion (of lymph or blood), and occasionally even gangrenous spots.

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[l] See some remarks on this subject by Mr. A. S. Taylor, in the *Guy's Hospital Reports,* No. xii.
[m] *Lond. Med. Gaz.* xix. 238, from *Amer. Journ. of Med. Sciences,* Aug. 1836.

β. *Morbid appearances of the vascular system.*—The blood is sometimes, though not invariably, fluid after death, and dark coloured. The heart is mostly flabby, and it is asserted that on its inner surface (especially the carneæ columnæ and valves, particularly of the left side), is observed redness, sometimes diffused, sometimes in the form of spots[n], which penetrate a line in depth into the substance of the heart. The pericardium usually contains serum.

γ. *Morbid appearances of the respiratory system.*—These are neither very remarkable nor constant, and principally consist in redness of the pleura, effusion of lymph or serum into the cavity of the pleura, red spots, and occasional congestion of the lungs, and redness of the membrane lining the air tubes.

ϑ. The *morbid appearances of other parts* deserve little attention. In some cases inflammation, and even gangrene, of the *genital* organs have been observed; the *conjunctiva* is sometimes very vascular, and alterations are occasionally observed in the condition of the *skin.* Redness, extravasation of blood, and effusion of serum, are said to have been seen in the *brain.*

In connexion with the morbid appearances produced by arsenic, the following remarks, made by Orfila[o], deserve notice. "Under certain circumstances the mucous membrane of the stomach and intestines is lined with a multitude of brilliant points, composed of fat and albumen: placed on burning coals these grains decrepitate on drying, and produce a noise which has been improperly denominated *detonation:* they inflame as a fatty body when they contain a notable quantity of fat, and exhale an odour of burned animal matter. These *fatty* and *albuminous* globules may be met with in the bodies of individuals who have not been poisoned, and require attentive examination in order to distinguish them from arsenious acid. The best method of avoiding this error is to digest these granular parts with water, and to apply the tests proper for demonstrating the existence of arsenious acid."

INFLUENCE OF ARSENIOUS ACID ON THE PUTREFACTIVE PROCESS.—Until the commencement of the present century it was supposed that the bodies of animals poisoned by arsenious acid were unusually prone to putrefaction. This, however, has been satisfactorily disproved by the experiments and observations of Klank, Kelch, Hünefield, and others[p]; and it appears that, when placed in contact with animal textures, it acts as an antiseptic. "I have kept a bit of ox's stomach four years in a solution of arsenic," says Dr. Christison, "and, except slight shrivelling and whitening, I could not observe any change produced in it." This antiseptic property of arsenious acid, which has been, in my opinion, fully and satisfactorily proved, sufficiently accounts for the good state of preservation in which the alimentary canal has been frequently found some months after death in those poisoned by this acid, where it was not evacuated by vomiting or purging[q].

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[n] White spots are frequently met with on the surface of the heart when no arsenic has been taken (*Guy's Hospital Reports*, vol. iii.)

[o] *Dict. de Méd.* ed. 2, art. *Arsenic.*

[p] Quoted by Wibmer, in his *Wirkung d. Arzneim. u. Gifte;* and by Dr. Christison, in his *Treatise on Poisons.*

But there is another effect said to be produced on the bodies of animals, which is not so easily accounted for: I mean their conversion into a kind of mummy-like or adipocirous matter. The following is an abstract of the phenomena, as deduced from numerous experiments and observations, several of which are recorded in Dr. Christison's invaluable *Treatise on Poisons.* After death putrefaction commences, and is attended with the usual odour; but, instead of increasing in the customary manner, it seems for a time to be at a stand-still, and then a series of changes commences of a peculiar character: the soft parts become firmer and drier, at the same time retaining their structure; the putrid odour is frequently succeeded by one resembling garlic; the skin becomes brown and parchment-like; the muscular fibres and cellular tissue (especially of the abdominal parietes) are changed into a tallowy cheesy-like mass; the liver, spleen, and heart, become dry, while the bowels, lungs, and brain, form a greasy mass. During these processes the quantity of arsenic in the body diminishes, probably by exhalation,—a circumstance very probable, when we bear in mind the garlic odour emitted by the body, and which has been observed by several writers. The diminution, however, must be exceedingly small. After some time the cheesy smell disappears, and the body becomes dry and hard. In some cases the alimentary tube has been found little changed or decomposed, although other parts of the body had been completely mummified.

I ought, however, to remark, that some writers do not ascribe these phenomena to the influence of arsenious acid, but to other causes. Jäger[r] tells us that in his experiments the putrefaction of the bodies of animals poisoned by arsenic seemed neither to be retarded nor hastened, whether they were buried or not; but he admits that parts in contact with an arsenical solution seem preserved from putrefaction. Seemann[s] likewise states, that the bodies of three dogs underwent the usual kind of putrefaction after death. However, that in many cases arsenic modifies the putrefactive process, can hardly, I think, be doubted by those who carefully examine the evidence adduced in favour of this opinion.

Does this mummifying process depend on the chemical influence of the arsenic, or ought we to refer it to a change effected by arsenic on the body, during life, causing "a different disposition and affinity among the ultimate elements of organized matter, and so altering the operation of physical laws in it?" The latter hypothesis, though advocated by Dr. Christison, appears to me untenable; for, in the first place, there is no evidence of any peculiar change of this kind during life; secondly, that this does not take place appears probable, from the putrefactive process commencing after death as usual; and it would appear that the peculiar influence of the arsenic does not commence, or at least is not evident, until this process has existed for some time, and when a garlic odour is evolved by the body. It is, indeed, true that the quantity of arsenic which has been detected in the body after death, is, as Dr. Christison remarks, "almost inappreciably small;" but it is probable that the quantity is much larger than chemists have yet been able to recognise: and it is not at all unlikely that the arsenious acid may enter into new combinations while within the dead body, and in this way become diffused, probably in a gaseous state: the garlic odour which is evolved favours this notion, as well as the statement made by some, that the quantity of arsenic in the body diminishes during the progress of the mummifying process.

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[q] In the dissecting-room of the London Hospital I have often witnessed the powerful and valuable antiseptic properties of arsenious acid. Subjects injected with this substance are but little changed at the expiration of one or two months, even during the summer season.

[r] Quoted by Wibmer, *op. cit.* i. 305.

[s] Quoted by Dr. Christison, *op. cit.* p. 322; also Wibmer, *op. cit.* i. 322.

MODUS OPERANDI.—When we consider that arsenious acid operates as a poison to whatever part of the body it be applied, the nerves and muscular fibres excepted; that the quickness with which it acts is in proportion to the absorbing powers of the part, and that the most soluble are the most energetic preparations, we can have little difficulty in admitting that absorption into the blood-vessels is necessary to the action of this potent agent. Lassaigne[t] states, that he detected it in the infiltrated pleura of a horse: and Fodéré[u] twice got indications of its presence in the urine: but Hardegg and Schubarth, on the other hand, failed to recognise it. An acquaintance of Beissenhirz[v] obtained nearly three grains of metallic arsenic from the stomach, cœcum, lungs, liver, heart, and brain of a horse poisoned by six drachms of arsenious acid, taken at divided doses: but the extraction of this substance from the stomach and cœcum is no evidence of its absorption. More recently, and by the aid of Marsh's apparatus, it has been detected in the liver and urine of dogs poisoned by it[w].

Arsenious acid appears to exercise a specific influence over several parts of the body, especially the alimentary canal, the heart, and the nervous system. That the *alimentary canal* is specifically affected is shown by the inflammation of the stomach, induced by the application of arsenic to wounds, and which, according to Sir B. Brodie[ww], is more violent and more immediate than when this poison is taken into the stomach itself. That the *heart* is also specifically acted on by arsenious acid is proved by the symptoms (the anxiety at the præcordia, the quick irregular pulse, &c.), and by the post-mortem appearances (red spots in the substance of this viscus), and by the diminished susceptibility to the galvanic influence. The specific affection of the *nervous system* is inferred from the symptoms: thus, the headache, giddiness, wandering pains, impaired sensibility of the extremities, and delirium or coma, are indications of the cerebral affection; while the feebleness, lassitude, trembling of the limbs, and paralysis or tetanic symptoms, are evidences of the disordered condition of the true spinal or excito-motory system of Dr. Hall.

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[t] *Lond. Med. and Phys. Journ.* vol. xlvi. p. 259, Aug. 1821.
[u] Quoted by Dr. Christison.
[v] Quoted by Wibmer, *op. cit.* i. 318.
[w] Report of the French Commissioners in the *Journ. de Pharm.* t. xxvii. p. 415.
[ww] *Phil. Trans.* for 1812, 205.

The alimentary canal, heart, and nervous system, are not the only parts on which this acid appears to exercise a specific influence: the lungs, the skin, the salivary glands, &c., are also specifically affected. The disorder of the *lungs* is inferred from the local pain, cough, and occasional inflammatory appearances after death. The eruptions and other altered appearances of the *skin*, and the falling off of the hair and nails (sometimes noticed), have led to the idea of the specific influence of arsenious acid on the cutaneous system,—an opinion which seems further supported by the fact of the remarkable influence it exercises in some cutaneous diseases, especially lepra. The salivation noticed by Marcus, Ferrier, Mr. Furley, Cazenave, and others, shews that the *salivary glands* are specifically influenced. The swelling of the face, and the irritation and redness of the eyelids, also deserve notice in connexion with the specific effects of this poison.

Uses.—So powerful a poison as arsenic necessarily requires to be employed with great caution, and to have its effects carefully and attentively watched; for it has on more than one occasion proved fatal when used as a medicinal agent.

In *intermittent fevers and other periodical diseases*, arsenic has been employed with great success. For its introduction into practice in these cases in this country, we are indebted to the late Dr. Fowler, of Stafford[a]; but Lemery and Wepfer appear to have first mentioned its febrifuge property. Dr. Fowler was led to its use from the beneficial effects obtained by the use of the "*Tasteless Ague Drop*," and from the information of Mr. Hughes, that this patent medicine was a preparation of arsenic. The reports published by Dr. Fowler, of the good effects of arsenic in periodical diseases, as observed by himself, by Dr. Arnold, and by Dr. Withering, have been amply confirmed by the subsequent experience of the profession generally. No remedy has been more successful in the treatment of ague. It will not unfrequently put a stop to the disease, even when cinchona or the sulphate of quina has failed. Dr. Brown[b], who has used it in many hundreds of cases, never saw any permanently ill effect arise from it: he considers it superior to crude bark, but inferior to quina: over both it has the advantages of cheapness and tastelessness. It should be given three times a day. It is not necessary to intermit its use during the febrile paroxysm, for I have repeatedly seen it given with the best effects during the attack. In agues, accompanied with inflammatory conditions, in which cinchona and sulphate of quina are apt to disagree, arsenic may, according to Dr. Brown, be sometimes administered with the best effects. It is also very successful in relapses after the use of the above remedies. Dr. Macculloch[z] states that $\frac{1}{16}$ of a grain of white arsenic given three or four times a day, will sometimes cure ague when the *liquor potassæ arsenitis* fails. A combination of arsenic and cinchona, or arsenic and sulphate of quina, sometimes succeeds, where these agents used separately fail. When the stomach is very irritable, opium is occasionally advantageously conjoined with arsenic. If the bowels be confined during the use of the remedy, gentle laxatives should be employed. Arsenic has been beneficially employed in various other periodical diseases; as periodical headaches, intermittent neuralgias, &c.

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[a] *Med. Rep. of the Effects of Arsenic*, 1786.

[b] *Cyclopædia of Practical Medicine*, i. 225

In various *chronic affections of the skin*, particularly the scaly diseases (lepra and psoriasis), eczema, and impetigo, arsenic is one of our most valuable agents. I can confidently recommend it in lepra, having seen a large number of cases treated by it without a single failure. Frequently the disease is relieved without any obvious constitutional effect: sometimes a febrile condition of the body is brought on, with a slight feeling of heat in the throat, and thirst; occasionally with an augmentation of appetite: the urine and cutaneous secretion are often promoted; the bowels may be constipated or relaxed, and occasionally, as I have already noticed, salivation takes place. If the patient complain of swelling and stiffness about the face, or itching of the eyelids, the use of the medicine ought to be immediately suspended. Ichthyosis and elephantiasis are said to have been benefited by the use of it[a].

Various chronic affections of the nervous system have been treated by the arsenious acid, and with occasional benefit: for example, neuralgia, epilepsy, chorea[b], and even tetanus. I have seen arsenic used in a considerable number of epileptic cases, and in none was the disease cured. In some the fits occurred less frequently, but I am not sure that this was the effect of the medicine. In chorea, I have seen great advantage attend its use. It has also relieved angina pectoris. It is said to possess the power of controlling determinations of blood to the head[c].

In bites of venomous snakes and of rabid animals, arsenious acid has been recommended. In India, the Tanjore pill (the basis of which is arsenious acid) has long been celebrated for the cure of the bite of the Cobra di Capello, and other venomous serpents. There is, however, no valid reason for supposing that it possesses any remedial power in these cases. Arsenic has been employed as an internal agent in various other diseases—as *chronic rheumatism*, especially when attended with pains in the bones; *in diseases of the bones*, particularly venereal nodes[d]; *in syphilis; in passive dropsies;* in the last stage of *typhus*, &c.[e]

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[z] *An Essay on the Remitt. and Intermitt. Diseases*, 1828.

[a] For further information on the use of arsenic in skin diseases, consult Rayer, *Treatise on Diseases of the Skin*, by Dr. Willis, p. 80.

[b] Dr. Gregory, *Med. Chirurg. Trans. of London*, xi. 299.

[c] *Edinb. Med. and Surg. Journ.* April 1839.

[d] Colhoun and Baer, *Amer. Med. Record.* iii. and iv.

[e] Ferriar, *Med. Hist.* i. 84.

Arsenious acid has long been employed as an *external application.* It has been applied and recommended by Sir A. Cooper, Dupuytren, and other high authorities, but its use is always attended with some danger. M. Roux, a celebrated surgeon at Paris, states[f] that he amputated the breast of a girl 18 years of age, on account of a scirrhus of considerable magnitude. After the cicatrix had been several days completed, ulceration commenced, accompanied with darting pains. To avoid frightening the girl by the use of the actual cautery, he applied an arsenical paste over a surface of about an inch in diameter. Colic, vomiting, and alteration of countenance, came on the next day; and in two days afterwards she died in violent convulsions. "I am convinced," says M. Roux, "that this girl died poisoned by arsenic." I could quote several other cases illustrative of the same fact, but shall content myself with referring to Wibmer's work[g] for an account of them. The following case, related by Desgranges[h], shews the danger of applying arsenic externally, even when the skin is sound:—A chamber-maid rubbed her head with an arsenical ointment, to destroy vermin. Though the skin was perfectly sound, the head began to swell in six or seven days after; the ears became twice their natural size, and covered with scabs, as were also several parts of the head; the glands of the jaw and face enlarged; the face was tumefied, and almost erysipelatous. Her pulse was hard, tense, and febrile; the tongue parched, and the skin dry. To these were added excruciating pain, and a sensation of great heat. Vertigo, fainting, cardialgia, occasional vomiting, ardor urinæ, constipation, trembling of the limbs, and delirium, were also present. In a day or two after, the body, and especially the hands and feet, were covered with a considerable eruption of small pimples, with white heads. She finally recovered, but during her convalescence the hair fell off.

Though employed as a caustic, yet the nature of its chemical influence on the animal tissues is unknown. Hence it is termed by some a *dynamical* caustic, in opposition to those caustics acting by known chemical agencies. Mr. Blackadder[i] asserts that the danger of employing arsenic consists in not applying a sufficient quantity. A small quantity, he says, becomes absorbed, whereas a large quantity quickly destroys the organization of the part, and stops absorption.

Arsenic has been extolled as a remedy for *cancer.* Justamond[j] esteemed it a specific. Various empirical compounds, which gained temporary notoriety in the treatment of this affection, owe their activity to either arsenious acid or the sesquisulphuret of arsenicum. But by the best surgeons of the present day it is never employed, because experience has fully shewn that it is incapable of curing genuine cancer, while it endangers the lives of the unfortunate patients. It cannot, however, be denied that diseases resembling cancer have been much relieved, if not cured, by it, and that the progress of cancer itself has occasionally been somewhat checked by its use.

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[f] *Nouv. Elem. de Méd.*

[g] *Die Wirkung.* &c

[h] Orfila's *Toxicol. Générale.*

[i] *Observations on Phagedena Gangrenosa.* Edinb. 1818.

[j] *An Account of the Methods pursued in the Treatment of Cancerous and Scirrhous Disorders, and other Indurations.* Lond. 1780.

In some forms of severe and unmanageable ulceration, especially *lupus* or *noli me tangere*, arsenical applications are employed with occasional benefit, where all other local remedies fail. In such cases arsenic is not to be regarded as a mere caustic; for other, and far more powerful agents of this kind, are generally useless. It must act by substitution: that is, it sets up a new action in the part incompatible with that of the disease. The late Baron Dupuytren employed an arsenical dusting powder (composed of 99 parts of calomel and 1 part arsenious acid) in lupus, not as an escharotic, but rather as a specific. Mixed with gum-water or with fatty matters, it has been sometimes used as a paste or ointment. These applications are to be allowed to fall off spontaneously, and to be repeated five or six times. Sir A. Cooper[k] recommends an arsenical ointment (arsenious acid; sublimed sulphur, āā. ʒj.; spermaceti cerate, ℥j.) to be applied, on lint, for twenty-four hours, and then to be removed. When the slough comes away, the ulcer is to be dressed with simple ointment, and will generally heal in a short time. Cazenave says he has seen arsenical applications used by Biett, and has himself employed them many times, without having met with one instance of injurious consequences. The arsenical paste (arsenious acid, cinnabar and burnt leather, made into a paste with saliva or gum-water) is used where a powerful action is required; but, besides the danger of causing constitutional symptoms, to which all arsenical compounds are liable, it is apt to occasion erysipelas.

In *onychia maligna*, my friend Mr. Luke regards an arsenical ointment (composed of arsenious acid, gr. ij., and spermaceti ointment, ℥j.) as almost a specific.

Arsenious acid is a constituent of some of the preparations sold as depilatories.

Administration.—Arsenious acid may be administered, in substance, in doses of from one-sixteenth to one-eighth of a grain, made into pills, with crumb of bread. In making a mass of pills, great care should be taken that the arsenic be equally divided; for this purpose it should be well rubbed in a mortar with some fine powder (as sugar) before adding the bread crumb. A much safer mode of exhibition is to give this potent remedy, in the form of solution, with potash (as the *liquor potassæ arsenitis*). But I have already mentioned, that Dr. Macculloch found solid arsenic more efficacious than this solution: and Dr. Physick, of the United States, thinks "that they act differently, and cannot be substituted for one another[l]." Whether given in the solid or liquid form, it is best to exhibit it immediately after a meal, when the stomach is filled with food: for when given on an empty stomach (as in the morning, fasting), it is much more apt to occasion gastric disorder. It is sometimes advisable to conjoin opium, either to enable the stomach to retain it, or to check purging. In debilitated constitutions, tonics may be usefully combined with it. An emetic (as ipecacuanha), or a laxative (as rhubarb), may be employed where the stomach is overloaded, or the bowels confined. Its effects are to be carefully watched, and whenever any unpleasant symptoms (as vomiting, griping, purging, swelling or redness of the eyelids, dryness of throat, ptyalism, headache, or tremors) make their appearance, it will of course be advisable to diminish the dose, or suspend for a few days the use of the remedy. Indeed, when none of these symptoms occur, it is not proper to continue its use more than two weeks without intermitting its employment for a day or two, in order to guard against the occasional ill consequences resulting from the accumulation of the poison in the system.

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[k] *Lancet*, i. 264.
[l] *United States Dispensatory.*

ANTIDOTES.—In cases of poisoning by arsenic, the first object is to expel the poison from the stomach. For this purpose the stomach-pump should be immediately applied. If this be not in readiness, and vomiting have not commenced, tickle the throat with a feather or the finger, and administer an emetic of sulphate of copper or sulphate of zinc. Promote vomiting by diluent and demulcent liquids; as milk, white of egg and water, flour and water, gruel, sugared water, and broths. Administer as speedily as possible moist hydrated sesquioxide of iron (the preparation of which will be hereafter described). The quantity necessary to be given to render the arsenic inert, is large. Dr. Maclagan[m] observes that "as far as chemical evidence goes, at least twelve parts of oxide, prepared by ammonia, and moist, are required for each part of arsenic." As, however, we cannot ascertain, in many instances, how much arsenic has been taken, we should administer to an adult a table-spoonful, at least, and to children, a dessert spoonful, every five or ten minutes, until relief from the urgent symptom is obtained[n]. The hydrated sesquioxide forms, with the arsenious acid, an arsenite of iron. This becomes a protarseniate of iron[o]. "The arsenious acid derives oxygen from the peroxide [sesquioxide] of iron, and becomes arsenic acid, while the peroxide of iron becomes protoxide; a protarseniate of iron being the result, which is insoluble and inert."

Charcoal, magnesia, and any inert powder, when swallowed in large quantities, may be occasionally of service, by enveloping the particles of arsenic, and preventing their contact with the gastric surface. Olive oil, on which, according to Dr. Paris[p], the Cornish miners rely with confidence, can only act mechanically in the way just mentioned.

The subsequent part of the treatment of poisoning by arsenic consists in neutralizing or counteracting its effects, and which is to be effected on general principles, as we have no counter-poison. When the gastro-enteritis is marked, our principal reliance must be on the usual antiphlogistic measures, particularly blood-letting, both general and local, and blisters to the abdomen. One drawback to the success of this treatment is the great depression of the vascular system, so that the patient cannot support large evacuations of blood. Opium is a very valuable agent. Indeed, Jäger seems to regard it in the light of a counter-poison. However, on this point he has probably taken a too exaggerated view of its efficacy; but it is undeniable that on most occasions it is of great service. If the stomach reject it, we may employ it in the form of clysters. If constipation and tenesmus be troublesome, mild laxatives, especially castor oil, should be exhibited.

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[m] *Edinb. Med. and Surg. Journ.* No. 144.

[n] Dr. T. R. Beck, *Lond. Med. Gaz.* Oct. 15, 1841.

[o] Graham's *Elements of Chemistry.*

[p] *Pharmacologia*

1. **LIQUOR POTASSÆ ARSENITIS**, L. *Liquor Arsenicalis*, E. D. *Fowler's Solution; Mineral Solution.*—(Arsenious Acid [broken in small pieces, *L.*; in powder, *E.*]; Carbonate of Potash, each grs. lxxx.; Compound Tincture of Lavender, fʒv.; Distilled Water, Oj. Boil the Arsenious Acid and Carbonate of Potash with half a pint of the Water in a glass vessel until they are dissolved. Add the Compound Tincture of Lavender to the cooled liquor. Lastly, add besides, of distilled water, as much as may be sufficient, that it may accurately fill a pint measure, *L. E.*—The preparation of the *Dublin College* is one-ninth weaker: the proportions of materials used are of Arsenious Acid, in powder; Carbonate of Potash, from Tartar, of each sixty grains; Compound Spirit of Lavender, fʒiv.; Distilled water, Oss. [*wine measure*]).—In this preparation the arsenious acid combines with the potash of the carbonate, and disengages the carbonic acid. A slight excess of carbonate is used. The compound tincture of lavender is used as a colouring and flavouring ingredient. The dose of this solution is four or five minims, gradually and cautiously increased. I have known 15 minims taken three times a day for a week, without any ill effects. Dr. Mitchell, of Ohio, has given from 15 to 20 drops, three times a day, in intermittents[q]. But as some persons are peculiarly susceptible of the influence of arsenic, we ought always to commence with small doses. It has been given to children, and even pregnant women. Dr. Dewees[r] administered it successfully to a child only six weeks old, affected with a severe tertian ague. Dr. Fowler drew up the following table of doses for patients of different ages:—

Ages.	Doses.
From 2 to 4 years	from 2 or 3 to 5 drops.
5 — 7 ,,	,, 5 — 7 ,,
8 — 12 ,,	,, 7 — 10 ,,
13 — 18 ,,	,, 10 — 12 ,,
18, and upwards	12 ,,

But it may be remarked that the quantities here indicated are larger than it will be safe, in most cases, to commence with.

2. **PILULÆ ASIATICÆ**: *Asiatic Pills*[s].—(Arsenious Acid, gr. lv.;

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[q] *United States Dispensatory.*

[r] *Philadelphia Journ. of Med. and Phys. Sc.* xiv. 187.

[s] *Asiatic Researches*, vol. ii. p. 153. The formula for these pills, given in the text, is that usually followed (Rayer, *Treatise on Skin Diseases*, by Willis, p. 1215). The original recipe is very indefinite: one tola [105 grs.] of arsenic and six times as much black pepper are to be made into pills "as large as tares or small pulse."

Powdered Black Pepper, ʒix.; Gum Arabic, a sufficient quantity to make 800 pills; each of which contain about $\frac{1}{15}$ of a grain of arsenious acid).—These pills are employed in the East for the cure of syphilis and elephantiasis.

3. **UNGUENTUM ARSENICI**; *Arsenical Ointment.*—An ointment containing arsenious acid is used of different strengths by surgeons. For onychia maligna I have already mentioned one containing two grains of arsenic to an ounce of lard or spermaceti ointment. The *Ceratum Arsenici* of the United States Pharmacopœia consists of arsenious acid, in very fine powder, ℈j.; Simple Cerate, ℥j. This is used as a dressing for cancerous sores, but must be applied with great circumspection (see another formula at p. 649).

4. **PASTA ARSENICALIS**; *Arsenical Paste.* — Various formulæ for this are given. The *Pulvis Escharotica Arsenicalis* (*Poudre caustique du frère Cosme ou de Rousselot*) of the French Codex is composed of finely levigated Cinnabar, 16 *parts;* powdered Dragon's Blood, 16 *parts;* finely levigated Arsenious Acid, 8 *parts.* Mix intimately. At the time of employing it, it is made into a paste, by means of a little saliva, or mucilage. This preparation is employed to cauterize cancerous wounds. It must be used very cautiously, and applied to limited portions only of the ulcerated surface. I have already referred to its occasional dangerous or fatal effects[t]. It deserves especial notice, that this officinal preparation of the French Codex is very considerably stronger than was used either by Rousselot or Come, notwithstanding that it is named after them[u].

OTHER COMPOUNDS OF ARSENICUM.

1. **ARSENICI IODIDUM**; *Iodide of Arsenic.*—This compound is prepared by gently heating, in a tubulated retort placed in a sand-bath, a mixture of one part finely pulverized metallic arsenicum and five parts of iodine: the iodide is afterwards to be sublimed, to separate the excess of arsenicum. The compound thus obtained is an orange-red solid, volatile, and soluble in water. If the solution be rapidly evaporated to dryness, we reprocure the iodide; but if we concentrate, and then place the solution aside, white pearly plates are obtained, which by Plisson are regarded as periodide of arsenicum, but by Serullas as a compound of oxide and iodide of arsenicum[v]. Iodide of arsenicum is probably composed of $1\frac{1}{2}$ eq. iodine $= 187{\cdot}5$, and 1 eq. arsenicum $= 38$. It has been employed by Biett in the form of ointment (composed of iodide of arsenicum, gr. iij.; lard, ℥j.) as an application to corroding tubercular skin diseases[w].

Dr. A. T. Thomson[x] has administered it internally in doses of from one-eighth to one-third of a grain, in lepra, impetigo, and diseases resembling carcinoma. Its general effects appear to be similar to those of arsenious acid.

2. **REALGAR:** *Red Sulphuret of Arsenic; Red Arsenic; Protosulphuret of Arsenic; Bisulphuret of Arsenic,* Graham; *Sandarach*[y] (σανδαράκη). Though this substance occurs native, the commercial article is prepared artificially. It is met with in the

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[t] See p. 646.

[u] For further information respecting Arsenical Paste, see Patrix, *L'Art d'appliquer la Pâte Arsenicale,* 8vo. Paris, 1816.

[v] Souberain, *Nouv. Traité de Pharm.* ii. 2nde ed. 580; also Serullas, *Journ. de Chim. Méd.* iii. 601.

[w] Magendie, *Formulaire.*

[x] *Lancet* for 1838-39, vol. i. p. 176.

[y] The term *Sandarach* is also applied to the resinous substance commonly called *Gum Juniper.*

form of red vitreous masses or as a red powder. It consists of 1 eq. *Arsenicum* 38 + 1 eq. *Sulphur* 16 = 54. It is an energetic poison. It was the agent employed by Mrs. Burdock to destroy Mrs. Smith[z]. The body of the victim was exhumed after having been buried for fourteen months. It was then discovered that the realgar had been transformed into orpiment, which was found in the stomach. Mr. Herapath[a] has shewn that ammonia and sulphuretted hydrogen (gases evolved during putrid decomposition) are each capable of converting realgar into orpiment. Realgar is not used in medicine, but is employed by pyrotechnists, and as a pigment. Heated with black flux it yields arsenicum (see p. 626).

3. **ORPIMENT**; *Yellow Sulphuret af Arsenic; Yellow Arsenic; Sesquisulphuret of Arsenic; Sulphoarsenious Acid; King's Yellow.*—This is both found native and prepared artificially. Native orpiment is the *Auripigmentum* of the ancients. Orpiment consists of 1 eq. Arsenicum 38, + 1½ eq. Sulphur 24 = 62. It is soluble in alkalis (by which it is readily distinguished from sulphuret of cadmium, which is insoluble in alkalis), and is precipitated from its alkaline solutions by acids. Heated with black flux it yields metallic arsenicum (see p. 626). As met with in the shops it is a powerful poison. It is a constituent of some depilatories (see p. 218). According to Dr. Paris, Delcroix's depilatory, called *Poudre Subtile*, consists of quicklime, orpiment, and some vegetable powder. Orpiment is used by pyrotechnists, and as a pigment.

ORDER XVIII.—COMPOUNDS OF ANTIMONY.

1. ANTIMO'NII SESQUISULPHURE'TUM, *L.*—SESQUISULPHURET OF ANTIMONY.

(Antimonii Sulphuretum, *E. D.*)

History.—Black sulphuret of antimony was known in the most ancient times, being used by the Asiatic and Greek ladies as a pigment for the eyebrows[b]. It was formerly called *Stimmi* (στίμμι vel στίμμις), *Stibium* (στίβι), *Platyophthalmon* (πλατυόφϑαλμον), or *Larbason*[c] (λάρβασον). In the native state it is technically termed *Antimony Ore*, and when first fused out of its gangue, *Crude Antimony*, or *Sulphuret of Antimony*.

Natural History.—Sesquisulphuret of antimony is found native in various parts of the world, especially in Hungary, in the Hartz, in France, in Cornwall, and in Borneo. From the latter place it is imported into this country by way of Singapore, being brought over as ballast to the vessels. In the years 1835-36, and 37, the quantities of ore imported were respectively 645, 825, and 629 tons (*Trade List*, Jan. 10, 1837, and Jan. 9, 1838). In 1840 there were imported 627 tons.

Preparation.—The old method of separating the sesquisulphuret from its siliceous gangue was to melt it in a covered crucible or pot, in the bottom of which there were several holes, through which the fused sulphuret passed into an inferior or receiving pot. According to Gensenne's method, the melting pots were placed in a circular reverberatory furnace, and were connected by curved earthen tubes with the receiving pots which were on the outside of the furnace. At La Vendée neither vessels nor tubes are used: the ore is placed on the bed of a reverberatory furnace, in which is an aperture to allow of the passage of the fused sesquisulphuret which flows into a receiving vessel placed externally to the furnace[d].

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[z] See the account of the celebrated Bristol case of poisoning, in the *Lond. Med. Gaz.* vol. xv. p. 519; and vol. xvi. p. 120.

[a] *Ibid.* vol. xviii. p. 888.

[b] 2 *Kings*, ix. 30; *Ezekiel*, xxiii. 40; Pliny, *Nat. Hist.* xxxiii.

[c] Dioscorides, lib. v. cap. 99.

PROPERTIES.—The fused sesquisulphuret (called *Common* or *Crude Antimony*) occurs in commerce in roundish masses, called loaves or cakes: these when broken present a striated crystalline appearance, a dark steel or lead grey colour, and a metallic brilliancy. The commercial sesquisulphuret is opake, tasteless, odourless, brittle, easily pulverizable, and has a sp. gr. of about 4·6. Its powder is black, but that of pure sesquisulphuret is reddish black. It is a little less fusible than metallic antimony. It is volatile, but cannot be distilled; and it appears to be partially decomposed by heat, for when heated in an earthen crucible for an hour it loses from 10 to 20 per cent. of its weight[e]. By roasting it is converted into *Antimony-Ash* or *Cinis Antimonii* (a mixture of antimonious acid and sesquioxide of antimony, with more or less unburned sesquisulphuret)[f]: sulphurous acid escapes during the process. When reduced to a very fine powder by levigation and elutriation it constitutes the *Antimonii Sulphuretum Præparatum* of the Dublin Pharmacopœia.

Characteristics.—It fuses and is dissipated before the blow-pipe with a smell of sulphurous acid and the formation of a white smoke. Digested in hydrochloric acid it evolves hydrosulphuric acid, and forms a solution of sesquichloride of antimony, which produces a white precipitate (*Powder of Algaroth*, or oxychloruret of antimony) with water, and an orange red one with hydrosulphuric acid. If a current of hydrogen gas be passed over heated sesquisulphuret of antimony, metallic antimony and hydrosulphuric acid gas are obtained: the metal decomposes nitric acid, and yields a white powder: it readily dissolves in nitro-hydrochloric acid.

COMPOSITION.—Sesquisulphuret of antimony has the following composition:

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Thomson.*
Antimony	1	65	73	72·8	73·77
Sulphur	1½	24	27	27·2	26·23
Sesquisulphuret of Antimony	1	89	100	100·0	100·00

IMPURITIES.—The crude antimony of commerce is rarely, if ever, quite pure. It frequently contains the sulphurets of iron, lead, arsenicum, and copper, and on this account is not adapted for medicinal use. When pure it is completely soluble in hydrochloric acid: but when mixed with sulphuret of arsenicum this remains undissolved, and may be detected by reducing it with a mixture of charcoal and carbonate of soda (*vide* p. 626). If the hydrochloric solution be diluted with water (so as to precipitate the greater part of the antimony), the presence of lead, iron, or copper, in the filtered liquor, may be detected by the appropriate tests for these metals, hereafter to be mentioned.

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[d] Dumas, *Traité de Chimie,* iv. 160.
[e] Berthier, *Traité des Essais,* ii. 490.
[f] Liebig, *Handwörterb. der Chemie,* i. 41

With heat it is totally dissolved by hydrochloric acid. From the acid in which it is boiled, a white precipitate is thrown down by distilled water; from the strained liquor, hydrosulphuric acid afterwards throws down a reddish coloured substance. *Ph. Lond.*

"Entirely soluble in muriatic acid, with the aid of heat." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—Rayer[g] introduced half an ounce of it into the cellular tissue of the back of a dog; but no effects resulted from it. Fifteen grains placed in the peritoneal sac caused inflammation, and in twenty-four hours death, but without any peculiar symptoms. Moiroud[h] says, that given to horses, in doses of from two to four ounces, it acts as an excitant, causing increased frequency of pulse and respiration, and softer stools.

β. *On Man.*—In most cases it produces no obvious effects, even when taken in very large doses. Rayer[i] gave half an ounce of it in powder, for several days, without the slightest effect. Cullen[j], however, has seen it cause nausea and vomiting in one or two instances in which it was largely employed. Rayer says that the decoction of the sesquisulphuret is much more active than an equal quantity of the same preparation in powder. How are these facts to be explained? Rayer ascribes the activity of the decoction to arsenious acid formed by boiling sulphuret of arsenicum (contained in the ordinary crude antimony) with water; for Guibourt[k] obtained in this way $1\frac{44}{100}$ grs. of arsenious acid by boiling an ounce of crude antimony. But the presence of arsenic is not necessary to explain the greater activity of the decoction, since by long-continued boiling with water, the sesquisulphuret of antimony yields hydrosulphuric acid and sesquioxide of antimony[l]. The occasional nausea and vomiting may arise from the decomposition of the sulphuret by the fluids in the alimentary canal.

USES.—As a medicinal agent it is occasionally employed as a diaphoretic and alterative in some skin diseases, especially lepra and scabies, in scrofula and glandular affections, and in rheumatism and gout.

As a pharmaceutical and chemical agent it is a most important substance, being the source from which the metal, and all its compounds, are procured.

ADMINISTRATION.—The usual dose of it, when taken internally, is from ten to thirty grains of the powder; but several drachms of it have been taken without much effect. The *Tisan de Feltz*, which is occasionally used in skin diseases, is prepared by boiling Sarsaparilla, ℥j., and Crude Antimony (tied up in a bag), ʒj., in a pint and a half of Water; then add Isinglass, ʒiv., previously dissolved in water, and reduce the whole (by boiling) to a pint, which is to be taken during the day[m].

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[g] *Dict. de Méd. et Chir. Pratiq.* iii. 54.

[h] *Pharm. Vétér.* 428.

[i] *Op. cit.*

[j] *Treat. of Mat. Med.* ii. 482.

[k] Rayer, *op. supra cit.*

[l] Geiger, *Handb. d. Pharm.*

ANTIMONII SULPHURETUM PRÆPARATUM, D. *Prepared Sulphuret of Antimony.* (Take of Sulphuret of Antimony any requisite quantity. Reduce to powder, according to the mode directed in the preparation of chalk, and let the most subtile particles be preserved for use). The powder sold in the shops as prepared sulphuret is usually prepared by grinding in mills without elutriation. Its uses are those of the sulphuret before described.

2. ANTIMO'NII SESQUICHLO'RIDUM.—SESQUICHLORIDE OF ANTIMONY.

History.—Basil Valentine was acquainted with this preparation, which has had various appellations; such as *Oil* or *Butter of Antimony* (*Oleum* seu *Butyrum Antimonii*), *Muriate* or *Hydrochlorate of Antimony*.

Preparation.—The impure hydrated sesquichloride, sold in the shops as butter of antimony, is usually prepared by dissolving roasted sesquisulphuret of antimony (*Cinis Antimonii*) in hydrochloric acid, and adding pernitrate of iron to the solution as a colouring matter. It may also be prepared by dissolving the common crude antimony in muriatic acid. The addition of a little nitric acid facilitates the process[n].

Pure sesquichloride of antimony is not used in medicine: its preparation need not, therefore, be described in this work.

Properties.—The *butter of antimony* of the shops is a transparent liquid, varying in its colour (which depends on the presence of iron) from yellow to deep red. Its specific gravity is 1·2 to 1·5. It fumes in the air (especially when ammonia is present), in consequence of containing an excess of hydrochloric acid. It reacts on vegetable colours as a powerful acid.

Characteristics.—Mixed with water it throws down a yellowish white powder called *Powder of Algaroth*, or *Mercury of Life* (oxychloride of antimony). The hydrosulphurets produce a dark reddish precipitate, alkalis a dirty white precipitate (*sesquioxide of antimony*, mixed with some *sesquioxide of iron*). Nitrate of silver occasions a white precipitate (*chloride of silver* and *sesquioxide of antimony*).

Composition.—Sesquichloride of antimony is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Göbel.*	*H. Rose.*
Antimony	1	65	54·62	54·98	53·27
Chlorine	1½	54	45·37	45·02	46·73
Sesquichloride Antimony	1	119	99·99	100·00	100·00

The Butter of Antimony of the shops contains *Sesquichloride of Antimony*, *Free Hydrochloric Acid*, a little *Nitrous Acid*, *Water*, and

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[m] Rayer, *Treatise on Diseases of the Skin*, by Dr. Willis, p. 1223.

[n] See *Antimonii Oxydum Nitromuriaticum*, D. p. 659.

Sesquichloride of Iron. It may also contain other impurities derived from the sesquisulphuret from which it is directly or indirectly prepared. Serullas says he never found arsenic in it.

PHYSIOLOGICAL EFFECTS.—It acts as an energetic caustic, but I am not acquainted with any cases of poisoning by it. It cannot be diluted without undergoing decomposition.

USES.—In medicine it is employed only as a caustic. It usually acts without much pain or inflammation, and, after the separation of the eschar, produces a clean healthy surface. It is sometimes used as an application to parts bitten by rabid animals or venomous serpents: its liquidity enabling it to penetrate into all parts of the wound. It is also applied to ulcers to repress excessive granulations. Richter and Beer have employed it in staphyloma: the mode of applying it is as follows:—Dip a camel's hair pencil, or a point of lint, into the liquid, and apply it to the tumour until a whitish crust is perceived, when the whole is to be immediately washed away by means of a larger pencil dipped first into milk and afterwards into milk and water.

ANTIDOTES.—The treatment of poisoning by this preparation is the same as for the mineral acids (*vide* pp 281 and 473.) After the use of antacids, vegetable astringents (tea and infusion of nutgalls) should be administered to neutralize the effect of the powder of Algaroth separated in the stomach. Gastro-enteritis is of course to be combated by the usual antiphlogistic means.

3. ANTIMO'NII OXYSULPHURE'TUM, *L.*—OXYSULPHURET OF ANTIMONY.

(Antimonii Sulphuretum aureum, *E.*—Sulphur Antimoniatum fuscum, *D.*)

HISTORY.—Basil Valentine[o] was acquainted with this preparation, and probably also knew the substance called *Kermes Mineral*, though he does not mention it in his writings. Glauber, in 1658, and Lemery, in 1707, are both said to be discoverers of the latter substance;' but it is hardly possible for Basil Valentine to have been unacquainted with it.

NATURAL HISTORY.—Kermes mineral, which is an oxysulphuret of antimony, though not identical with, yet nearly allied to, the preparation of the Pharmacopœia, is found native in Saxony and other places: it is called by mineralogists *Red Antimony* or *Native Kermes.*

PREPARATION.—All the British Colleges give directions for the preparation of this substance.

The *London College* orders of Sesquisulphuret of Antimony, ℥vij.; Solution of Potash, Oiv.; Distilled Water, *Cong.*, ij.; Diluted Sulphuric Acid as much as may be sufficient. Mix the Sesquisulphuret of Antimony, Solution of Potash, and Water together, and boil with a slow fire for two hours, frequently stirring,

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[o] *Triumphant Chariot of Antimony*, by Kirkringius, p. 131. Lond. 1678.

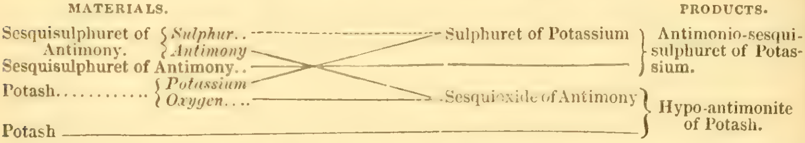
Distilled Water being often added, that it may fill about the same measure. Strain the liquor, and gradually pour into it as much diluted Sulphuric Acid as may be sufficient to precipitate the Hydrosulphuret of Antimony; then, with water, wash away the Sulphate of Potash, and dry what remains with a gentle heat.

The *Edinburgh College* orders of Sulphuret of Antimony, in fine powder, ℥j.; Solution of Potash, f℥xj.; Water, Oij.

The *Dublin College* directs of Prepared Sulphuret of Antimony, *one part;* Water of Caustic Potash, *eighteen parts;* Diluted Sulphuric Acid, *eleven parts,* or as much as may be sufficient.

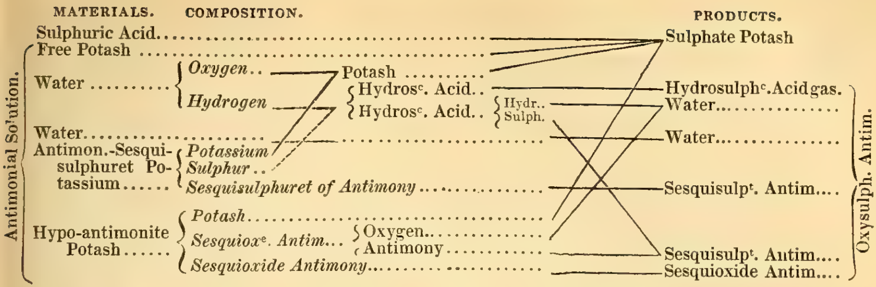
Theory of the Process.—If black or sesquisulphuret of antimony be boiled in an alkaline liquid, a solution is obtained which, on cooling, deposits a reddish powder called *Kermes Mineral.* If a dilute mineral acid be added to the filtered mother liquor, an orange red precipitate is produced, called the *Golden Sulphuret of Antimony* (Berzelius; Liebig). If the acid be added before the kermes has deposited, we obtain the orange red precipitate, called in the London Pharmacopœia *Oxysulphuret of Antimony.* The Edinburgh College terms the latter substance the *Golden Sulphuret of Antimony.*

When sesquisulphuret of antimony and potash are heated together, the latter gives oxygen to the antimony, and potassium to the sulphur of the sesquisulphuret; and thus sesquioxide of antimony and sulphuret of potassium are produced. The sesquioxide combines with some undecomposed potash, forming *hypo-antimonite of potash,* and the sulphuret of potassium with sesquisulphuret of antimony, forming a double sulphur salt (the *antimonio-sesquisulphuret of potassium*). These changes are explained in the subjoined diagram:—



The solution contains free potash, the antimonio-sesquisulphuret of potassium, and part of the hypo-antimonite of potash. There is a dark-red, undissolved residuum (similar to *Crocus Antimonii*) composed of hypo-antimonite of potash and oxysulphuret of antimony: this is got rid of by filtering.

On the addition of sulphuric acid, sulphate of potash is produced by the combination of the acid with free potash,—with some potash formed by the union of the potassium of the sulphuret with the oxygen of some decomposed water,—and with the potash of the hypo-antimonite. By these changes sesquisulphuret and sesquioxide of antimony are set free: the whole of the first, and part of the second, precipitate. The hydrogen of the decomposed water, with the sulphur of the sulphuret of potassium, form hydrosulphuric acid, a portion of which escapes in a gaseous form, while the remainder, reacting on some sesquioxide of antimony, produces water and sesquisulphuret, which are precipitated along with some water of the solution. These changes will be better comprehended by reference to the following diagram:—



For further details respecting the theory of this process I must refer the student to the writings of Berzelius [p] and Liebig [q].

Properties.—Oxysulphuret of antimony is a red, odourless, almost tasteless powder. It is insoluble in cold water, and only slightly soluble in liquor ammoniæ. Boiled in nitro-hydrochloric acid, chloride of antimony is formed in solution, and some sulphur remains undissolved. Heated in the air it burns, evolves sulphurous acid, and leaves a greyish residuum.

Characteristics.—When heated with concentrated hydrochloric acid, it evolves hydrosulphuric acid, shewing it to be a sulphuret. From the other sulphurets or oxysulphurets of antimony it is to be distinguished partly by its colour. Its hydrochloric solution is shewn to contain antimony by the tests before mentioned for the sesquichloride of this metal (*vide* p. 654). When boiled in a solution of bitartrate of potash, a solution of emetic tartar is obtained, which may be recognised by the characters hereafter to be mentioned for this salt. It may be reduced by hydrogen and heat (*vide* p. 667).

Composition.—By boiling in a solution of bitartrate of potash, it loses, according to Mr. Phillips, 12 per cent.; the amount of sesquioxide that it contains. Its composition, according to the same authority, is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Phillips.*
Sesquioxide Antimony	1	77	13	12
Sesquisulphuret Antimony	5	445	75	76·5
Water	8	72	12	11·5
Oxysulphuret Antimony, *Ph. L.*	1	594	100	100·0

The *Antimonii Sulphuretum aureum*, Ph. Ed., has a similar composition. The Edinburgh College, however, states that it is a mixture or compound of *sesquisulphuret of antimony*, *sesquioxide of antimony*, and *sulphur*. The sesquisulphuret and sesquioxide are perhaps only mechanically mixed.

The commercial oxysulphuret is of a brighter colour than that obtained according to the process of the Pharmacopœia. A manufacturer of it informs me that it is prepared by boiling sulphur along with the sesquisulphuret of antimony and potash, and precipitating by an acid in the usual way.

Kermes Mineral consists of two equivalents of sesquisulphuret of antimony and one equivalent of sesquioxide of antimony (consequently it has the same composition as *Red Antimony Ore*), and commonly contains also from 1 to 1½ per cent. of alkali combined with sesquioxide of antimony. By continued washing with water the hypo-antimonite of potash and sesquioxide of antimony may be extracted, leaving the sesquisulphuret only[r].

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[p] *Traité de Chimie*, ii. 501.

[q] *Handwörterb. d. Chemie*, i. 439.

The term *Golden Sulphuret of Antimony* is usually applied to the persulphuret of antimony, which consists of 1 eq. of antimony and 2½ eqs. of sulphur[s].

Purity.—Recently precipitated oxysulphuret of antimony is readily and completely soluble in liquor potassæ: but the oxysulphuret of the shops leaves a white residuum. Boiled in hydrochloric acid, it is dissolved with the evolution of hydrosulphuric acid gas: the solution is opalescent or slightly milky, but becomes quite transparent on the addition of a small quantity of nitric acid. It should not effervesce with dilute sulphuric acid.

The *London College* states that it is

> Totally soluble in nitro-hydrochloric acid, emitting hydrosulphuric acid.

But I find that it is not completely soluble in nitro-hydrochloric acid;—a portion of sulphur remaining behind.

The *Edinburgh College* states that it is

> "Tasteless: twelve times its weight of muriatic acid, aided by heat, will dissolve most of it, forming a colourless solution, and leaving a little sulphur."

Physiological Effects.—The medicinal activity of this preparation is principally or wholly owing to sesquioxide of antimony; and, as the quantity of this is probably inconstant, the preparation is uncertain in its operation. The obvious effects are precisely analogous to those of emetic tartar; namely, vomiting, purging, and sweating. In small doses it is employed as an alterative, expectorant, and diaphoretic: in somewhat larger doses it causes nausea and sweating, and sometimes vomiting: in still larger quantities it excites both vomiting and purging[t].

Use.—It is principally employed as an *alterative* in chronic diseases, particularly cutaneous affections, glandular enlargements, secondary syphilis, rheumatism, and diseases of the liver. In these complaints it is usually associated with mercurials (especially calomel), and sometimes with guaiacum or narcotics. Kermes mineral has been employed as an antiphlogistic in inflammatory affections of the respiratory organs, and sometimes as an *emetic*.

Administration.—As an alterative the dose is from one to three or four grains: as an emetic from five grains to a scruple. It is a constituent of the *Pilulæ Hydrargyri Chloridi Compositæ*, commonly termed *Plummer's pill*.

Antidotes.—Vide *Potassæ Antimonio-tartras*.

4. ANTIMO'NII SESQUIOX'YDUM.—SESQUIOXIDE OF ANTIMONY.

(Antimonii Oxydum, *E.*—Antimonii Oxydum Nitromuriaticum, *D.*)

History.—Basil Valentine[u] was acquainted with sesquioxide of antimony prepared by the combustion of the metal, and which he termed *Flowers of Antimony* (*Flores Antimonii*). He also knew that the same compound might be procured by the action of water on the sesquichloride of antimony.

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[r] Liebig, *Handwörterb. d. Chimie*, i. 427.

[s] Liebig, *op. cit.* i. 430.

[t] For some experiments and observations on the action of *Kermes Mineral* and the *Golden Sulphuret*, consult Rayer, in *Dict. de Méd. et Chir. Prat.* iii. 57, *et seq.*

[u] *Triumphant Chariot of Antimony*, by Kirkringius, p. 91. Lond. 1678.

Natural History.—This oxide is found native, and is known to mineralogists as *White Antimony*. It is found in Bohemia, Saxony, Hungary, &c.

Preparation.—There are various methods of preparing this oxide.

The *Edinburgh College* direct it to be prepared as follows:—"Take of Sulphuret of Antimony, in fine powder, ℥iv.; Muriatic Acid (commercial), Oj.; Water, Ov. Dissolve the sulphuret in the acid, with the aid of a gentle heat; boil for half an hour; filter. Pour the fluid into the water; collect the precipitate on a calico filter; wash it well with cold water, then with a weak solution of carbonate of soda, and again with cold water, till the water ceases to affect reddened litmus paper. Dry the powder over the vapour-bath.

The *Dublin College* order of prepared Sulphuret of Antimony, *twenty parts;* Muriatic Acid, *one hundred parts;* Nitric Acid, *one part.* Gradually add the sulphuret to the acids, previously mixed in a glass vessel, avoiding the vapours; then with a heat gradually increased, digest, until the mixture ceases to effervesce; then boil during an hour. Receive the cooled and filtered liquor in a gallon of water. Let the oxide of antimony, when it has subsided, be washed with a sufficiently abundant quantity of water, until the decanted fluid shall have become free from acid, which may be ascertained by means of litmus: finally, let the oxide be dried on bibulous paper.

By the mutual reaction of sesquisulphuret of antimony and hydrochloric acid, a soluble sesquichloride of antimony is formed (see p. 654). The Dublin College uses a small quantity of nitric acid to decompose the hydrosulphuric acid remaining in the liquor, and which would impair the colour of the precipitate. When water is added to the solution of the sesquichloride, mutual reaction occurs, the products of which are free hydrochloric acid and sesquioxide of antimony; the latter combines with some undecomposed sesquichloride of antimony, and forms the Oxychloride of antimony, commonly termed the *Pulvis Algarothi*, *Algaroth's Powder* (from Algarotti, an Italian physician, who recommended its use in medicine). It is sometimes called the *Mercury of Life (Mercurius Vitæ)*. By continued washing with hot water, the sesquichloride which it contains is decomposed, and the product is sesquioxide of antimony.

When Algaroth's powder is washed with a solution of carbonate of soda, its sesquichloride is converted into sesquioxide of antimony by the action of the soda. Chloride of sodium is also formed, and carbonic acid evolved.

Properties.—Sesquioxide of antimony occurs native in tabular and acicular crystals, which belong to the right prismatic system. When prepared in the moist way it is a white powder, which becomes yellow by heat, and fuses at a full red heat into a yellow fluid, which concretes by cooling into a crystalline mass. If subjected to heat in the open air it absorbs oxygen, and becomes antimonious acid.

Characteristics.—Heated in liquid hydrochloric acid it completely dissolves: the solution contains sesquichloride of antimony, which, when mixed with water, yields a white precipitate (*oxychloride of antimony*). Hydrosulphurets form a red precipitate in the solution of the sesquichloride. Boiled with a solution of bitartrate of potash it is dissolved: the solution yields on cooling crystals of emetic tartar, the characteristics of which will be hereafter given. Sesquioxide of antimony melts before the blowpipe, and is volatilized in the form of a white vapour.

Composition.—Sesquichloride of antimony (*Antimonii Oxydum*, Ph. Ed.) has the following composition:—

	Atoms.	Eq. Wt.	Per Cent.	Berzelius.	John Davy.
Antimony	1	65	84·4	84·319	85
Oxygen	1½	12	15·6	15·681	15
Sesquioxide of Antimony	1	77	100·0	100·000	100

Oxychloride of Antimony (*Antimonii Oxydum Nitro-muriaticum*, Ph. Dub.) is a compound of sesquioxide and sesquichloride of antimony. The proportion of the latter ingredient is diminished by washing. The composition of the oxychloride is thus stated by Phillips, Johnson, and Malaguti [v]:—

	Atoms.	Eq. Wt.	Per Cent.
Sesquioxide Antimony	9	693	74·44
Sesquichloride Antimony	2	238	25·56
Oxychloride Antimony	1	931	100·00

Antimony Ash (*Cinis Antimonii*) is composed of *antimonious acid*, *sesquioxide of antimony*, and *sesquisulphuret of antimony* [w].

Glass of Antimony (*Vitrum Antimonii*) is prepared by roasting the sesquisulphuret, and subsequently fusing it in an earthen crucible. It is transparent and of a red colour. It consists principally of *sesquioxide of antimony*, some *sesquisulphuret of antimony*, and about five per cent. of *silica* [x].

Purity.—The Edinburgh College give the following characteristics of its purity:—

"Entirely soluble in muriatic acid, and also in a boiling mixture of water and bitartrate of potash: snow-white: fusible at a full-red heat."

Physiological Effects and Uses.—Sesquioxide of antimony possesses similar medicinal properties to Emetic Tartar, in the preparation of which it is used. It is rarely employed as a medicine. Algaroth's powder is uncertain in its operation.

Administration.—Algaroth's powder is sometimes given in doses of from one to ten grains.

5. PUL'VIS ANTIMO'NII COMPO'SITUS, *L.*—COMPOUND POWDER OF ANTIMONY.

(Pulvis Antimonialis, *E. D.*)

History.—Dr. James, who died in 1776, prepared a celebrated patent medicine, long known as the *Fever Powder of Dr. James* (*Pulvis Febrifugus Jacobi*), or *Dr. James's Powder* (*Pulvis Jacobi*). The discovery of it was subsequently claimed for a German of the name of Schwanberg[y]. The specification which Dr. James lodged in the Court of Chancery is so ambiguously worded, that we cannot prepare his powder by it. Hence the present preparation has been introduced into the Pharmacopœia as a succedaneum for it. In preceding editions of the London Pharmacopœia it was termed *Pulvis Antimonialis* (*Antimonial Powder*); but in the edition for 1836 this name was unnecessarily (as I conceive) altered to *Pulvis Antimonii Compositus.*

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[v] Brande, *Manual of Chemistry*, 5th ed. p. 854.

[w] See p. 652.

[x] Phillips, *Translation of the Pharmacopœia of the Royal College of Physicians*, for 1824. Lond. 1824, p. 81.

PREPARATION.—All the British Colleges give directions for its preparation.

The *London College* orders, of Sesquisulphuret of Antimony, powdered, lbj.; Horn Shavings, lbij. Mix, and throw them into a crucible red-hot in the fire, and stir constantly until vapour no longer arises. Rub that which remains to powder, and put it into a proper crucible. Then apply fire, and increase it gradually, that it may be red-hot for two hours. Rub the residue to a very fine powder.

The *Edinburgh College* directs equal weights of Sulphuret of Antimony, in coarse powder, and Hartshorn in shavings, to be used. "Mix them, put them into a red-hot iron pot, and stir constantly till they acquire an ash-gray colour, and vapours no longer arise. Pulverise the product, and put it into a crucible with a perforated cover, and expose this to a gradually-increasing heat till a white heat be produced, which is to be maintained for two hours. Reduce the product, when cold, to fine powder.

The process of the *Dublin College* is essentially similar to that of the London College.

Manufacturers usually substitute bone sawings for hartshorn shavings.

The following is the *theory* of the process: the gelatinous matter of the horn (or bones) is decomposed and burned off, leaving behind the earthy matter (subphosphate of lime, with a little calcareous carbonate). The sulphur of the sesquisulphuret is expelled in the form of sulphurous acid, while the antimony attracts oxygen from the air, forming antimonious acid, and a variable quantity of sesquioxide of antimony. By the subsequent heating the sesquioxide is, for the most part, converted into antimonious acid; but one portion is usually left unchanged, while another is volatilized. The carbonate of lime of the horn is decomposed by the united agencies of heat and antimonious acid: carbonic acid is expelled, and a small quantity of antimonite of lime formed. The sides of the crucible in which the second stage of the process has been conducted, are found, at the end of the operation, to be lined with a yellow glaze, and frequently with yellow crystals of sesquioxide.

PROPERTIES.—Antimonial powder is white, gritty, tasteless, and odourless. Boiling water extracts the antimonite (and, according to Dr. Maclagan, superphosphate of lime): the liquid becomes cloudy on cooling. Hydrochloric acid, digested in the residue, dissolves the subphosphate of lime, all the sesquioxide of antimony, and that portion of the antimonious acid which was in combination with lime.

Characteristics.—The solution obtained by boiling antimonial powder in distilled water occasions white precipitates, soluble in nitric acid, with oxalate of ammonia, nitrate of silver, and acetate of lead. The precipitate with the first of these tests is oxalate of lime, with the second phosphate of silver, and with the third phosphate of lead. Hydrosulphuric acid gas transmitted through the solution, produces an orange red precipitate. If the portions of antimonial powder not dissolved by distilled water be digested in boiling liquid hydrochloric acid, a solution is obtained, which, on the addition of distilled water, becomes turbid, and deposits a white powder (*oxychloride of antimony*): at least I have found this to take place with several samples of antimonial powder which I have examined, and the same is noticed by Dr. Barker[z]; but neither Mr. Phillips[a] nor Dr. Maclagan[b] have observed it. Hydrosulphuric acid gas, transmitted through the hydrochloric solution, causes an orange-red precipitate: if this be separated by filtering, and the solution boiled to expel any traces of hydrosulphuric acid, a white precipitate (*subphosphate of lime*) is thrown down on the addition of caustic ammonia. That portion of antimonial powder which is not dissolved by hydrochloric acid is antimonious acid: if it be mixed with charcoal, and heated to redness, it is converted into sesquioxide, or metallic antimony.

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[y] *Affidavits and Proceedings of W. Baker*, Lond. 1754.

"Distilled water, boiled with it and filtered, gives, with sulphuretted hydrogen, an orange precipitate: muriatic, digested with the residue, becomes yellow, does not [*sometimes does, according to my experiments*] become turbid by dilution, but gives a copious orange precipitate with sulphuretted hydrogen." *Ph. Ed.* 2nd ed. 1841.

COMPOSITION.—*Dr. James's Powder* has been analysed by Dr. Pearson[c], by Mr. Phillips[d], by Berzelius[e], by M. Pully[f], by Dr. D. Maclagan[g], and was imperfectly examined by Mr. Chenevix[h]. *Antimonial Powder* has been analyzed by Mr. Phillips[i], and by Dr. D. Maclagan[j]. Their results are, for the most part, shown in the following table:—

	JAMES'S POWDER.					ANTIMONIAL POWDER.		
	Pearson	Phillips.	Berzel.	Maclagan.		Phillips.		Maclagan.
		Newbury's		Newbury's	Butler's	1st samp.	2d do.	
Antimonite of Lime [with some superphosphate, *Maclagan*]	—	—	1	3·40	2·25	—	—	0·8
Sesquioxide of Antimony ..	—	—	—	2·89	9·80	—	—	3·98
Antimonious Acid	57	56·0	66	43·47	34·21	35	38	50·09
Subphosphate of Lime	43	42·2	33	50·24	53·21	65	62	45·13
Loss [Sesquioxide of Antimony and impurity, *Phillips*]	—	1·8	—	—	0·53	—	—	—
	100	100·0	100	100·00	100·0	100	100	100·00

According to the Edinburgh Pharmacopœia (2nd ed. 1841), antimonial powder is "A mixture chiefly of *antimonious acid* and *phosphate of lime*, with some *sesquioxide of antimony* and a little *antimonite of lime*."

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[z] *Observations on the Dublin Pharmacopœia*, 204.
[a] *Ann. Phil.* iv. N. S. 266.
[b] *Edinburgh Med. and Surg. Journ.* No. 135.
[c] *Phil. Trans.* lxxxi. for 1791, p. 317.
[d] *Ann. Phil.* N. S. vi. 187.
[e] *Traité de Chimie*, iv. 481.
[f] *Ann. de Chim.* 1805, lv. 74.
[g] *Op. supra cit.*
[h] *Phil. Trans.* for 1801, p. 57.
[i] *Ann. Phil.* N. S. iv. 266.
[j] *Op. cit.*

Pully found *sulphate of potash* and *hypo-antimonite of potash* in James's powder. Mr. Brande has found as much as 5 per cent. of sesquioxide of antimony in the antimonial powder of the shops.

The *antimonite of lime* is obtained in solution by boiling antimonial powder in distilled water: the greater part of it deposits as the solution cools. The existence of *superphosphate* was inferred by Dr. Maclagan, from the precipitates produced with the salts of lead and nitrate of silver. Mr. Phillips states that it contains but little, if any, *sesquioxide of antimony*, because the hydrochloric solution did not let fall any precipitate on the addition of water. But a small quantity of sesquioxide may be dissolved by this acid without our being able to obtain any evidence of it by the action of water. Dr. Maclagan[k] has shown, that if hydrosulphuric acid gas be transmitted through the solution, an orange red precipitate is obtained, which he supposes to be an indication of the presence of sesquioxide. But unless the antimonial powder be boiled *repeatedly* in water, to remove completely the antimonite of lime, this test cannot be relied on: for if the least trace of this salt be present, on the addition of hydrochloric acid bichloride of antimony is obtained, which, it is well known, not only produces an orange red precipitate with hydrosulphuric acid, but even causes a white precipitate on the addition of water[l].

PHYSIOLOGICAL EFFECTS.—Antimonial powder is most unequal in its operation,—at one time possessing considerable activity, at another being inert, or nearly so. This depends on the presence or absence of sesquioxide of antimony, which may be regarded as constituting its active principle, and which, when present, is found in uncertain and inconstant quantity. Moreover, this variation in the composition of antimonial powder cannot be regarded as the fault of the manufacturer, since it depends, as Mr. Brande[m] has justly observed, "upon slight modifications in the process, which can scarcely be controlled."

Mr. Hawkins gave ʒj. morning and evening without any obvious effect; and the late Dr. Duncan, jun. administered ℈j. and ʒss. doses, several times a-day, without inducing vomiting or purging[n]. Dr. Elliotson[o] found even 120 grains nearly inert; nausea alone being in some of the cases produced. In these instances I presume it contained little or no sesquioxide.

But, on the other hand, a considerable number of practitioners have found it to possess activity. Dr. Paris[p] observes, that "it will be difficult for the chemist to persuade the physician that he can never have derived any benefit from the exhibition of antimonial powder." I have above stated that the experiments on which Mr. Phillips founds his assertion that this preparation contains but little if any sesquioxide, are inclusive, as Dr. Maclagan[q] has shewn. I am acquainted with one case in which it acted with great activity. A workman employed in the manufacture of this powder in the laboratory of an operative chemist in London, took a dose of it (which, from his account,

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[k] *Op. cit.*

[l] Gmelin, *Handb. der Chemie*, ii. 986.

[m] *Manual of Pharmacy*, 3d. ed. p. 292.

[n] *Edinb. New Dispensat.* 11th ed.

[o] *Cases illustrative of the Efficacy of the Hydrocyanic Acid*, p. 77.

[p] *Pharmacologia.*

[q] *Op. cit.*

I estimate at half a teaspoonful), and, to use his own words, "it nearly killed him." It occasioned violent vomiting, purging, and sweating.

Dr. James's powder, which some practitioners consider as more active and certain than our antimonial powder, appears to be equally inconstant in its operation. Dr. D. Munro[r], who frequently used this powder, and saw Dr. James himself, as well as other practitioners, administer it, observes—"like other active preparations of antimony, it sometimes acts with great violence, even when given in small doses; at other times a large dose produces very little visible effects. I have seen three grains operate briskly, both upwards and downwards; and I was once called to a patient, to whom Dr. James had himself given five grains of it, and it purged and vomited the lady for twenty-four hours, and in that time gave her between twenty and thirty stools; at other times I have seen a scruple produce little or no visible effect." Dr. Cheyne[s] thought highly of it in the apoplectic diathesis: but he used it in conjunction with bleeding, purgatives, and a strict antiphlogistic regimen.

The preceding facts seem to me to shew the propriety of omitting the use of both antimonial and James's powder, and substituting for them some antimonial of known and uniform activity; as emetic tartar (see p. 679).

Uses.—Antimonial powder is employed as a sudorific in fevers and rheumatic affections. In the former it is given either alone or in combination with mercurials: in the latter it is frequently conjoined with opium as well as with calomel. In chronic skin diseases it is sometimes exhibited with alteratives.

Administration.—The usual dose of it is from 3 or 4 to 8 or 10 grains, in the form of powder or bolus.

6. POTAS'SÆ ANTIMO'NIO-TAR'TRAS.—ANTIMONY-TARTRATE OF POTASH.

(Antimonii Potassio-Tartras, *L.*—Antimonium Tartarizatum, *E.* –Antimonii et Potassæ Tartras sive Tartarum Emeticum, *D.*)

History.—This salt was first publicly noticed in 1631, by Adrian de Mynsicht[t]. Besides the names above mentioned it has been known by various others, as *Tartarized Antimony*, *Emetic Tartar*, and *Stibiated Tartar (Tartarus Stibiatus)*.

Preparation.—Antimony-tartrate of potash is prepared by boiling water, and bitartrate of potash with sesquioxide of antimony or with some antimonial preparation which contains it, as the oxychloride or oxysulphuret of antimony.

Antimony-ash (Cinis Antimonii), procured by roasting the sesquisulphuret, is employed to yield the sesquioxide in an extensive manufactory in London. As already stated (p. 652), this compound is a mixture of sesquioxide, antimonious acid, and some undecomposed sesquisulphuret. The proportions of ash and bitartrate used vary according to the quality of the former: the average being equal parts. This, I am informed, is the cheapest method of obtaining emetic tartar.

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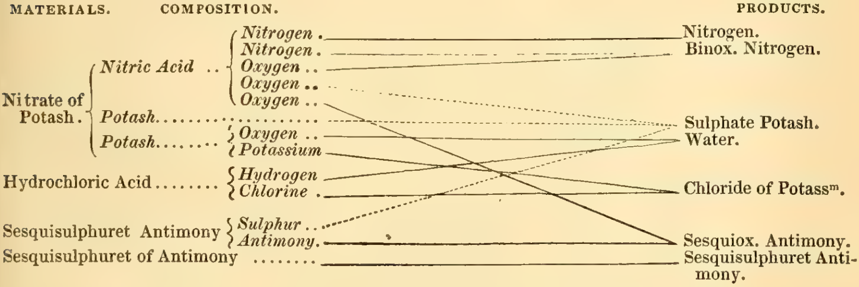
[r] *Treatise on Med. and Pharm. Chem.* i. 367.
[s] *Dubl. Hosp. Rep.* i. 315.
[t] *Thesaurus Medico-Chymicus.*

The *London College* directs this salt to be prepared as follows:—Take of Sesquisulphuret of Antimony, rubbed to powder; Nitrate of Potash, powdered, each, lbij.; Bitartrate of Potash, powdered, ℥xiv.; Hydrochloric Acid, f℥iv.; Distilled Water, *cong.* j. Accurately mix the Sesquisulphuret of Antimony with the Nitrate of Potash; the Hydrochloric Acid being then added, and the powder spread upon iron plate, ignite it. Rub what remains to very fine powder, when it is cold, and wash it frequently with boiling water until it is free from taste. Mix the powder thus prepared with the Bitartrate of Potash, and boil for half an hour in a gallon of distilled water. Strain the liquor while hot, and set it aside that crystals may be formed. These being removed and dried, let the liquor again evaporate that it may yield crystals.

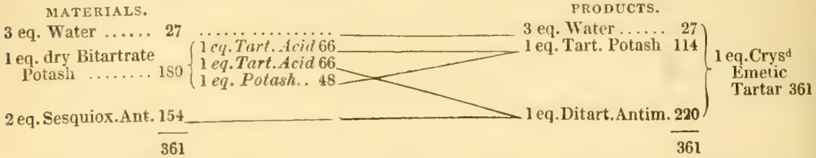
The *theory* of the process is this: part of the sulphur and of the antimony are oxidized at the expense of the oxygen of the acid of the nitrate, by which sulphuric acid and sesquioxide of antimony are formed, while nitrogen and binoxide of nitrogen escape. The sulphuric acid unites with part of the potash of the nitrate. The hydrochloric acid reacts on another portion of potash, and produces water and chloride of potassium. If no hydrochloric acid had been employed, the potash would react on some undecomposed sesquisulphuret, and generate antimonio-sesquisulphuret of potassium and sesquioxide of antimony. The residuum of this operation is, then, sulphate of potash, chloride of potassium, sesquioxide of antimony, and some undecomposed sesquisulphuret of antimony. By washing, the sulphate and chloride are got rid of. The following diagram, though imperfect, may perhaps assist the student in comprehending the foregoing changes:—



Six equivalents of nitrate, 7 equivalents of sesquisulphuret, and 1½ equivalents of hydrochloric acid, contain the elements of 6 eqs. of binoxide of nitrogen, 4½ eqs. of sulphate of potash, 1½ eqs. of water, 1½ eqs. of chloride of potassium, 3 eqs. sesquioxide of antimony, and 4 eqs. sesquisulphuret.

MATERIALS.		PRODUCTS.	
6 eqs. Nitrate of Potash	612	6 eqs. Binoxide of Nitrogen	180
7 eqs. Sesquisulphuret of Antimony	623	4½ eqs. Sulphate of Potash	396
1½ eqs. Hydrochloric Acid	55·5	1½ eqs. Water	13·5
		1½ eqs. Chloride of Potassium	114
		3 eqs. Sesquioxide of Antimony	231
		4 eqs. Sesquisulphuret of Antimony	356
	1290·5		1290·5

The changes in the second stage of the process are readily comprehended: two equivalents or 154 parts of sesquioxide of antimony combine with one equivalent or 180 parts of dry bitartrate of potash, to form one equivalent or 334 parts of dry emetic tartar, which, in crystallizing, unite with three equivalents, or 27 parts of water. The sesquisulphuret is unacted on by the bitartrate of potash.



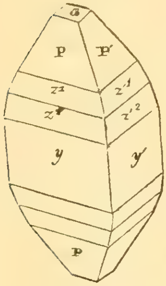
The *Edinburgh College* gives the following directions for the preparation of this salt:—Take of Sulphuret of Antimony, in fine powder, ʒiv.; Muriatic Acid (commercial), Oj.; Water, Ov. Dissolve the sulphuret in the acid with the aid of a gentle heat; boil for half an hour; filter; pour the liquid into the water; collect the precipitate on a calico filter, wash it with cold water till the water ceases to redden litmus paper; dry the precipitate over the vapour bath. Take of this precipitate, ʒiij.; Bitartrate of Potash, ℥iv. and ʒij.; Water, f℥xxvij. Mix the powders, add the water, boil for an hour, filter, and set the liquid aside to crystallize. The mother liquor when concentrated yields more crystals, but not so free of colour, and, therefore, requiring a second crystallization.

By the mutual reaction of sesquisulphuret of antimony and hydrochloric acid, we obtain a sesquichloride of antimony (see p. 654). When this is mixed with water an oxichloride of antimony is precipitated (see p. 659). The sesquioxide contained in this unites with the bitartrate of potash and forms emetic water.

The *Dublin College* orders Emetic Tartar to be prepared with Nitro-Muriatic Oxide of Antimony (Oxichloride, see p. 659), *four parts;* Bitartrate of Potash, triturated to a most subtile powder, *five parts;* Distilled Water, *thirty-four parts.*

PROPERTIES.—Emetic tartar crystallizes in white, transparent, inodorous, rhombic, octohedrons, whose lateral planes are striated. By exposure to the air the crystals become opake, probably by giving out an equivalent of water. Their taste is feebly sweetish, then styptic and metallic. They dissolve in 14 or 15 parts of water at 60° F. ($12\frac{65}{100}$ at 70°, Brandes),—and in two parts ($2\frac{78}{100}$ parts, Brandes) at 212°. The aqueous solution slightly reddens litmus and undergoes decomposition by keeping, like solutions of tartaric acid and most tartrates[u]. Emetic tartar is not soluble in alcohol. When calcined in close vessels it yields a pyrophoric alloy of antimony and potassium. The crystals decrepitate in the fire.

FIG. 117.



Octohedron of Emetic Tartar.

Characteristics.—Heated in a porcelain or glass capsule this salt is charred, shewing that it contains an organic substance (tartaric acid). If the charred salt be heated in a glass tube by a blowpipe, globules of antimony are obtained.

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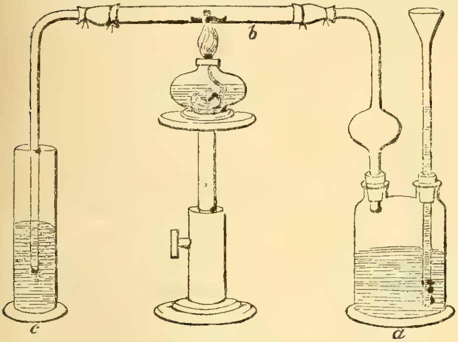
[u] The soft flexible mass which forms in a solution of Emetic Tartar, is said by Keitzing (*Repertoire de Chimie*, t. iii. p. 278; Paris, 1838) to be a vegetable organized being, which he has described and figured as before stated (see p. 411).

If a stream of hydrosulphuric acid gas be transmitted through a watery solution of emetic tartar (*vide* fig. 111, p. 629), the latter becomes orange-red: if a small quantity of hydrochloric acid be then added, a flocculent orange-red precipitate (*hydrated sesquisulphuret of antimony*) takes place. This precipitate is to be collected and dried, and introduced into a green glass tube, and a current of hydrogen gas transmitted over it. When the process has gone on for a few minutes, the heat of a spirit-lamp should be applied to the sesquisulphuret: hydrosulphuric acid and metallic antimony are produced. A portion of the latter is [spuriously?] sublimed. The metal is known to be antimony by dissolving it in nitro-hydrochloric acid: the solution forms a white precipitate (*Powder of Algaroth*) on the addition of water, and an orange-red one with hydrosulphuric acid gas, or hydrosulphate of ammonia. The mode of reducing the sesquisulphuret will be readily understood by the accompanying woodcut (fig. 118). This process was proposed by the late Dr. E. Turner.

FIG. 118.



Apparatus for reducing Sulphuret of Antimony.

a. Vessel for generating Hydrogen.
b. Reduction tube.
c. Vessel containing solution of Acetate of Lead to detect the Hydrosulphuric Acid which is formed.

A solution of emetic tartar forms *white* precipitates with oxalic and the strong mineral acids, the alkalis and their carbonates, and lime water: *greyish* or *yellowish-white* (*tannate of antimony*) with infusion of nutgalls: and *reddish* with the soluble hydrosulphates. Their relative delicacy, as well as the delicacy of hydrosulphuric acid, has been thus determined by Devergie[v]:—

	Dilution of the Solution.
Hydrochloric acid does not form a precipitate at..........	2,500
Sulphuric (or oxalic) acid........ditto....................	1,000
Tincture of nutgalls ....ditto	1,000
Lime water......................stops at...	1,200
Potash (soda, ammonia, or carbonate of ammonia) stops at	2,000
Hydrosulphuric acid (or hydrosulphate of ammonia) ditto	100,000

The sesquioxide of antimony, thrown down by the alkalis, is soluble in an excess of the precipitant. The precipitate formed by sulphuric or nitric acid is the sesquioxide combined with a small quantity of the acid. Acetic acid does not occasion any precipitate.

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[v] *Méd. Leg.* ii. 770.

COMPOSITION.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Wallquist.*	*R. Phill.*	*Thomson.*
Sesquioxide of Antimony	2	154	42·65	42·99	43·35	42·62
Potash	1	48	13·29	13·26	49·25	57·38
Tartaric Acid	2	132	36·56	38·61		
Water	3	27	7·47	5·14	7·40	
Emetic Tartar	1	361	99·97	100·00	100·00	100·00

or

	Atoms.	*Eq. Wt.*	*Per Cent.*
Ditartrate of Antimony	1	220	60·94
Tartrate Potash	1	114	31·57
Water	3	27	7·47
	1	361	99·98

PURITY.—In the crystalline state the purity of this salt is easily determined. The crystals should be well formed, perfectly colourless, transparent, or opaque, and, when dropped into a solution of hydrosulphuric acid, have an orange-coloured deposit formed on them.

When pure the powder of this salt is perfectly white. Some ignorant druggists prefer a yellowish white powder, and I am informed by a manufacturer of this salt that he is obliged to keep two varieties (one white, the other yellowish white), to meet the demands of his customers! The yellow tint is owing to the presence of iron, which is readily detected in the salt by the blue colour immediately produced in its solution by adding first a few drops of dilute sulphuric acid, and then ferrocyanide of potassium.

Emetic tartar is sometimes adulterated with bitartrate of potash. According to Mr. Hennell[u], the antimonial salt may contain 10 per cent. of bitartrate, and yet the whole will dissolve in the proper quantity (14 or 15 parts) of water. In order to detect any uncombined bitartrate, he adds a few drops of a solution of carbonate of soda to a boiling solution of the antimonial salt, and if the precipitate formed be not dissolved, he concludes that there is no bitartrate of potash present.

A dilute solution of emetic tartar occasions no precipitate with chloride of barium: it produces a white precipitate (unless the solutions be very dilute) with nitrate of silver, soluble in excess of water.

Totally soluble in water, no bitartrate of potash remaining in the vessel; and hydrosulphuric acid being added, a reddish coloured precipitate is obtained. Neither chloride of barium nor nitrate of silver being added to [a dilute] solution, precipitates any thing. Nitric acid throws down a precipitate, which is dissolved by an excess of it. *Ph. L.*

"Entirely soluble in twenty parts of water; solution colourless, and not affected by solution of ferrocyanide of potassium: a solution in forty parts of water is not affected by its own volume of a solution of eight parts of acetate of lead in thirty-two parts of water and fifteen parts of acetic acid." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Emetic tartar acts as a poison to plants[v].

β. On Animals.—An extended examination of the effects of emetic tartar on the different classes of animals is still a desideratum. Hitherto experiments with it have been principally confined to dogs, rabbits, horses, oxen, sheep, and cats. Moiroud[w] has given two drachms to horses, and gradually increased the dose to six ounces, without perceiving any remarkable and permanent derangement in the exercise of the principal functions. Gilbert (quoted by Moiroud) has exhibited ten drachms to a cow, and four to a sheep, without any remarkable effect: but six drachms killed an animal of the latter species. Magendie[x] examined its effects on dogs. He found that from six to ten grains introduced into the stomach killed the animals in from two to three hours, when the gullet was tied: those who were able to get rid of it by vomiting took as much as a drachm without experiencing any bad effects, and in some cases half an ounce caused no ill effects. From his experiments it appears to operate locally and by absorption, its principal action being on the intestinal canal and lungs: for nausea, vomiting, alvine evacuations, difficulty of respiration, and accelerated respiration, were produced by injecting a solution of the salt into the veins, by introducing it into the stomach, as well as by applying it in the solid state to the cellular tissue. Traces of pneumonia, gastritis, and enteritis, were found after death. These experiments have been repeated by Rayer and Bonnet[y] on rabbits; but without obtaining the lesion of the lungs mentioned by Magendie: in some cases no appreciable lesion was observed in any organ. Dr. Campbell (quoted by Dr. Christison) found no pulmonary inflammation in a cat killed by this salt. According to Flourens[z], emetic tartar injected into the veins of ruminants causes efforts to vomit, but not actual vomiting; of the four stomachs possessed by these animals, the *reed* or true stomach is the only one affected by it. Orfila[a] has detected antimony in the viscera of animals to whom emetic tartar had been administered by the stomach.

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[u] Phillips's *Transl. of the Pharm.* 4th ed.

[v] Schübler and Zeller, in *Schweigger's Journ. f. d. Chem.* 1827, B. 50, S 54-66.

[w] *Pharm. Vétér.* 287.

γ. *On Man.* αα. *Local effects.*—Emetic tartar is a powerful local irritant. Its irritant properties may be regarded as of a peculiar or specific kind; at least if we are to judge from its well-known effects when applied to the epidermis (as in the form of solution or ointment, or sprinkled over a plaster). It causes an eruption of painful pustules, resembling those of variola or ecthyma. The smaller ones are semiglobular; the larger ones, when at their height, are flattened, are surrounded with an inflammatory border, contain a pseudo-membranous deposit and some purulent serum, and have a central dark point. When they have attained their greatest magnitude, the central brown spots become larger and darker, and, in a few days, desiccation takes place, and the crusts are thrown off. The largest are produced by using the powder sprinkled over a plaster; the smallest are developed by applying the solution. They are usually very painful. I am acquainted with no agent which produces an eruption precisely similar. The facility with which this eruption is produced varies considerably in different individuals, and in the same individual at different times.

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[x] Orfila, *Toxicol. Gén.*

[y] *Dict. de Méd. et de Chir. Prat.* iii. 69.

[z] *Mémoires de l'Academie Royale des Sciences*, t. xvi. 1838; also *Journal de Chimie Méd.* ix. 21.

[a] *Journ. de Chim. Méd.* t. vi. 11e Série, p. 290. See also the Report of the Commissioners of the French Academy of Sciences, in the *Journ. de Pharm.* xxvii. p. 415.

A similar pustular eruption has been met with in the mouth, œsophagus, and small intestines, from the internal use of emetic tartar, and white aphthous spots have been observed on the velum and tonsils[b]. But these effects are rare. Severe inflammation of the throat (*angina antimonialis?*) has sometimes followed the employment of antimony[c].

We have further evidence of the local irritation produced by emetic tartar, in its action on the stomach and intestines. When swallowed in full doses it gives rise to vomiting and purging, and pain in the epigastric region. After death, redness of the gastro-intestinal membrane has been found. However, it would appear from the experiments of Magendie, before referred to, that part of this effect should be referred to the specific influence which emetic tartar exerts over the stomach, independent of its direct local irritation, since the same symptoms have been induced by the application of this substance to wounds, or by its injection into the veins.

Occasionally constitutional effects (nausea, vomiting, and griping pains) have appeared to result from the application of emetic tartar to the skin[d]. In one instance death resulted from its employment: the patient was an infant two years of age, and death occurred in forty-eight hours[e]. These effects, if really produced by this salt, occur very rarely. I have applied to the skin emetic tartar (in the form of solution, ointment, and plaster) in a very large number of cases, without having observed any constitutional effect; though I have occasionally fancied that it ameliorated pulmonary affections, even when no eruption or redness was produced, and which might arise from absorption[f].

ββ. Remote or *constitutional effects.*—Taken internally, *in small doses,* emetic tartar increases the secretion and exhalation of the gastro-enteritic membrane, and of the liver and pancreas. Subsequently it acts powerfully on other emunctories: thus it causes sweating, without any very marked vascular excitement; it renders the mucous membranes (especially the aërian membrane) moister, and, when the skin is kept cool, promotes the secretion of urine. These effects are produced more certainly and speedily by this salt than by any other antimonial preparation.

In somewhat larger doses it excites nausea, frequently with vomiting, disorders the digestive functions, gives rise to an uneasy sensation in the abdominal region, depresses the nervous functions, relaxes the tissues (especially the muscular fibres), and occasions a feeling of great feebleness and exhaustion. These symptoms are accompanied or followed by increased secretion and exhalation from the different emunctories, but especially from the skin, as above mentioned. Of all emetic substances this creates the most nausea and depression.

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[b] Lepelletier, *De l'Emploi du Tart. Stibié*, p. 171. Paris, 1835.
[c] *Lond. Med. Gaz.* March 20, 1840, p. 960.
[d] *Journ. de Chimie Méd.* iv. 478.
[e] *Med. Repos.* xvi. 357.
[f] See also some experiments on this subject in *Mem. of the Med. Soc. Lond.* vols. ii. iv. and v.

In excessive doses emetic tartar has, in a few instances, acted as an irritant poison, and even occasioned death. In one case a scruple, in another 27 grains, nearly proved fatal[g]. In a third 40 grains caused death[h]. The symptoms in the latter case were vomiting, hypercatharsis, convulsions, epigastric pain and tumefaction, and delirium. Death occurred four days after the ingestion of the poison.

Were the above cases not well authenticated, we should be disposed to ascribe the dangerous symptoms, and death, to some other circumstance than the use of the above-mentioned quantities of emetic tartar; for of late years this salt has been extensively employed in enormous and repeated doses with perfect safety. Rasori[i] has given many drachms in twenty-four hours, and many ounces during the course of a disease, without occasioning either vomiting or abundant alvine evacuations. Laennec[j] has confirmed, to a certain extent, the statements of Rasori. He gave a scruple, two scruples, and even a drachm and a half, within twenty-four hours (usually in doses of one, two, or three grains) without ever having seen any injurious consequences. The usual effects which I have observed from the continued use of one or two grain doses, are, nausea, vomiting, and purging, which in most cases are much diminished, or entirely cease, after the use of the medicine for a day or two. Perspiration I have found to be a frequent effect. In all the instances above referred to, in which these large doses were administered, the patients were affected with inflammatory diseases. Now it is to this morbid state, or *diathesis*, that, according to Rasori[k], we ought to ascribe the *tolerance* of, or capability or *aptitude* of bearing, these immense quantities of so powerful a medicine (*vide* p. 129 for some remarks on the Italian *theory of contra-stimulus*). Consequently, if the opinion be worth any thing, the susceptibility to the influence of the medicine should increase as the disease subsides; a circumstance which Rasori asserts really takes place. But in this the theoretical views of this distinguished Italian have probably led him to overlook the fact. "It is certainly true," observes Laennec[l], "that after the acute period of the disease [peripneumonia], the tolerance diminishes, or sometimes entirely ceases; but it is more common to find the patient become habituated to the medicine, insomuch that during convalescence, and when he has begun to use food as in health, he will take daily, without knowing it, six, nine, twelve, or even eighteen grains of the emetic tartar." Though I have seen this salt extensively employed in both public and private practice, I have never met any satisfactory cases supporting Rasori's assertion of the diminished tolerance when the patient becomes convalescent. Moreover, large doses have been taken by healthy individuals without any remarkable effects.

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[g] Orfila, *Toxicol. Gén.*
[h] *Ibid.*
[i] Bayle's *Bibliothéq. de Thérap.* i. 198.
[j] *Treatise on Diseases of the Chest*, by Dr. Forbes, p. 249.
[k] *Op. cit.*
[l] *Op. cit.*

Alibert[m] saw, at the Hôpital St. Louis, a man who took a drachm of this salt, in order to poison himself, but suffered no remarkable inconvenience from it. Lebreton[n] reports the case of a girl who swallowed six drachms at once as a poison: oil was immediately given; vomiting took place, and she soon recovered. Other published cases might be brought forward in proof of the slight effects of large doses of this salt, but I must content myself with referring to the Memoir of Magendie[o] for notices of them. I may add, however, that this distinguished physiologist concludes, that the comparative slightness of the effects arose from the evacuation of the salt a few moments after its ingestion; but in several, at least, of the cases, this was not proved; and in one it certainly did not happen: it was that of a man who swallowed 27 grains of this salt, and did not vomit.

The action of large doses of emetic tartar on the circulation and respiration is usually that of a sedative. This has been very frequently, though not constantly observed. In one case of peripneumonia, the daily use of from six to eight grains of this salt reduced the pulse, in nine days, from 120 to 34 beats per minute, and diminished the number of inspirations from 50 to 18[p]. In another the pulse descended, in three days, from 72 to 44 beats per minute[q].

Modus Operandi.—Emetic tartar (or the antimony of this salt) has been detected in the viscera of animals, as I have already stated, M. Barré[r], however, endeavoured to prove that emetic tartar could not be absorbed by the healthy mucous membrane of the alimentary canal. Minaret[s] states that a young woman labouring under pleuritis took emetic tartar, which operated on the child at her breast as well as on herself.

Several parts of the body are influenced by this salt. The specific affection of the *alimentary canal* (especially of the stomach) is shewn by the vomiting[t] and purging produced, not only when the medicine is swallowed, but when it is injected into the veins or into the windpipe, or when applied to the serous coats of the intestines, or to the cellular tissue. If it purge or occasion sweating, it usually causes thirst, but not commonly otherwise. The appetite and digestion are frequently unimpaired. After the use of it for some days, patients sometimes complain of irritation in the mouth and throat, with a metallic taste: this has been considered a sign that the system is saturated with antimony, and that the use of it should be suspended. A pustular eruption has occasionally appeared in the mouth, as I have already mentioned (p. 669).

Magendie ascribes to emetic tartar a specific power of causing engorgement or inflammation of the *lungs;* for he found, on opening the bodies of animals killed by it, that the lungs were of an orange red or violet colour, incapable of crepitating, gorged with blood, and here and there hepatized. Moreover, it has been assumed that the same effects are produced in the human pulmonary organs; and in support of this opinion a case noticed by Jules Cloquet[u] has been referred to: it is that of a man who died of apoplexy, but who, within five days of his death, had taken 40 grains of tartar emetic. "In the lungs were observed very irregular blackish spots, which extended more or less deeply into the parenchyma of this organ." Furthermore, it is argued, that unless we admit a specific influence of antimony over the lungs, we cannot well explain the beneficial effects of this remedy in peripneumonia. In opposition to this view, I would remark, that in cases of poisoning by this substance in the human subject, no mention is made of difficulty of breathing, cough, pain, or other symptom, which could lead to the suspicion that the lungs were suffering; and in the case of poisoning related by Recamier[v], we are distinctly told that the thorax was sound. Besides, we should expect that if emetic tartar had a tendency to inflame the lungs, or at least to occasion pulmonary engorgement, that large doses of it would not be very beneficial in acute peripneumonia. It would even seem that this substance must have an influence over the human lungs of an opposite kind to that supposed by Magendie; for, as already related, it reduces the frequency of respiration in a considerable number of instances.

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[m] *Nouv. Elém. d. Thérap.* 5me ed. i. 259.
[n] Orfila, *Toxicol. Gén.*
[o] *De l'Influence de l'Emetique.*
[p] Bouneau et Constant, quoted by Lepelletier, *De l'emploi du Tart. Stib.* 84.
[q] Trousseau, quoted by Lepelletier.
[r] Quoted by Rayer, *Dict. de Méd. et de Chir. Prat.* iii. 69.
[s] *Lond. Med. Gaz.* xiii. 496.
[t] For some observations on the mode by which this salt induces vomiting, see p. 267.

The sedative influence of emetic tartar over the *circulatory system* has been already noticed: it is, however, not always evident.

The great depression of the muscular power, the diminution of the frequency of the pulse and fainting, the epigastric pain sometimes experienced under circumstances that almost preclude the supposition of gastric inflammation, the cramps and convulsions, the delirium and insensibility, caused by emetic tartar in poisonous doses, are referrible to the influence of this substance over the *nervous system.*

The *absorbent system* is supposed to be stimulated to greater activity by emetic tartar, in consequence of the disappearance of serous and synovial effusions under its use. Moreover, Laennec[w] ascribed the efficacy of it in peripneumonia to the increased activity of the interstitial absorption[x].

The influence of it over the *secreting organs* has been before referred to[y]. Every one is familiar with its diaphoretic properties. Its diuretic effect is best seen when the skin is kept cool, and when neither vomiting nor purging supervene. Magendie says, it augmented the secretion of saliva in dogs; and the same effect has been observed in man by Drs. Griffith and Jackson. The menstrual discharge is not checked by it; but occasionally has come on under its use.

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[u] Orfila, *Toxicol. Gén.*

[v] Orfila, *op. cit.*

[w] *Op. cit.* p. 203.

[x] I have already made some observations on the mode by which resolvents operate: see p. 196.

[y] See *Liquefacientia,* p. 194.

Uses.—As an *emetic*, this salt is usually administered by the stomach, but it is sometimes used as an enema, and occasionally is injected into the veins. When administered by the stomach, it is generally given in doses of one or two grains, frequently in combination with ten or fifteen grains of ipecacuanha. When our object is merely to evacuate the contents of the stomach, and with as little constitutional disorder as possible (as in cases of narcotic poisoning), other emetics (as the sulphates of zinc and copper) are to be preferred, since they occasion less nausea and depression of system, while they excite speedy vomiting. On the other hand, when we use vomiting as a means of making an impression on the system, and thereby of putting a sudden stop to the progress of a disease, emetic tartar is by far our best vomit. It is with this view that it is sometimes employed in the early stages of fever, especially when accompanied by gastric or bilious disorder. It is most efficacious when given at the very commencement of the symptoms, and before the disease is fully formed. In such cases it occasionally puts an entire stop to the progress of fever. But, unfortunately, the practitioner is not usually called in to see the patient until the proper period for the exhibition of an emetic has passed by,—that is, until the disease is fully established. Emetic tartar is used as a vomit, with considerable success, in the early stage of inflammatory diseases; especially in croup, tonsillitis, swelled testicle, bubo, and ophthalmia. Here, also, the success of the remedy is in proportion to its early application. In croup it should be given to excite in the first instance vomiting, and afterwards prolonged nausea. Under this plan of treatment I have seen two or three slight cases completely recover without the use of any other remedial agent. Dr. Copland[y] also bears testimony to the success of the practice. In most cases it will be found advisable to precede the use of this medicine by blood-letting. Dr. Cheyne[z] advises the employment of emetic tartar in the second stage of croup, for the purpose of moderating vascular action, and of promoting the separation of the adventitious membrane. But I am disposed to rely chiefly on calomel (given so as speedily to occasion ptyalism) and blood-letting. Dr. Cheyne recommends half a grain of emetic tartar to be dissolved in a table-spoonful of water, and given to a child two or three years of age, every half hour till sickness and vomiting are produced; and, in two hours after the last act of vomiting, the same process is to be recommenced, and so repeated while the strength will admit. Another disease which is relieved by the occasional use of emetics is *hooping-cough*. They should be administered at the commencement of the disease, every, or every other day. They diminish the violence and length of the fits of spasmodic coughing, and promote expectoration. Emetic tartar is particularly valuable in this disease in consequence of being tasteless, and, therefore, peculiarly adapted for exhibition to children. In derangements of the hepatic functions, indicating the employment of emetics, this salt is usually preferred to other vomiting agents, on account of its supposed influence in promoting the secretion of bile.

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[y] *Dict. of Pract. Med.* i. 467.

[z] *Essay on Cynanche Trachealis,* 1801.

Clysters containing emetic tartar have been employed to occasion vomiting, but they are very uncertain in their operation. Rayer has frequently employed from six to twelve grains without producing either nausea or vomiting.

It has been repeatedly *injected into the veins* to excite vomiting. The usual dose is two or three grains dissolved in two ounces of water; but in some cases six grains have been employed. The effects are unequal: when vomiting does occur it is not always immediate; frequently it does not take place at all [a]. In several cases of choking, from the lodgment of pieces of meat in the œsophagus, this remedy has been applied with great success: vomiting was produced, and with it the expulsion of the meat. It has also been tried in epilepsy and trismus: but frequently with dangerous consequences [b]. Meckel employed it to restore animation in asphyxia by drowning [c]. It has also been used in tetanus [d].

As a *nauseant*, to reduce the force of the circulation and the muscular power, emetic tartar is frequently of considerable service. Thus, in dislocations of the larger joints (the hip and shoulder, for example), blood-letting, and nauseating doses of emetic tartar, are employed to diminish the resistance of the muscles opposing the reduction. Even in strangulated hernia it has been given [dd].

Emetic tartar, in large doses, is a most powerful and valuable remedy in the treatment of inflammation, especially peripneumonia. As an emetic, nauseant, or diaphoretic, it has long been in use in this disease; having been employed by Riverius in the 17th century, and subsequently by Stoll, Brendel, Schroeder, and Richter, in Germany; by Pringle, Cullen, and Marryat, in England. But as a remedy for inflammation, independent of its evacuant effects, we are indebted for it to Rasori [e] who first used it in the years 1799 and 1800, in an epidemic fever which raged at Genoa. Subsequently he exhibited it much more extensively, and in larger doses, in peripneumonia. This mode of treatment was tried and adopted in France, first by Laennec [f]; and in this country by Dr. Balfour [g]. Its value as an antiphlogistic is now almost universally admitted. Practitioners, however, are not quite agreed as to the best method of using it. Rasori [h], Laennec [i], Recamier [j], Broussais [k], Bouillaud [l], Dr. Mackintosh [m], Drs. Graves and

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[a] Dieffenbach, *Transf. d. Blut. u. d. Infus. d. Arzn.*
[b] *Ibid.* p. 49.
[c] *Ibid.*
[d] *Lancet* for 1836-37, vol. i. p. 35.
[dd] *Ibid.* p. 876.
[e] See the French translation of his Memoir, in Bayle's *Biblioth. de Thérap.* i. 198.
[f] *Treatise on Diseases of the Chest*, translated by Dr. Forbes.
[g] *Illustrations of the Power of Emetic Tartar*, 2d edit. 1819.
[h] *Op. cit.*
[i] *Op. cit.*
[j] *Gazette Médicale*, 1832, p. 503.
[k] *Cours de Pathologie et de Thérapeutique générale*, ii. 521.
[l] *Dictionnaire de Médecine et de Chirurgie pratique*, xiii. 495.
[m] *Practice of Physic*, i. 426.

Stokes[n], Dr. Davis[o] and most practitioners of this country, employ blood-letting in peripneumonia, in conjunction with the use of emetic tartar. But by several continental physicians the abstraction of blood is considered both unnecessary and hurtful. Thus Peschier[p] advises on no account to draw blood: and Trousseau[q] observes, that blood-letting, far from aiding the action of emetic tartar, as Rasori, Laennec, and most practitioners, imagine, is, on the contrary, singularly injurious to the antiphlogistic influence of this medicine. Louis[r] has published some numerical results of the treatment of inflammation of the lungs by blood-letting and by emetic tartar; from which it appears that this substance, given in large doses, where blood-letting appeared to have no effect, had a favourable action, and appeared to diminish the mortality[s]. But he particularly states that blood-letting must not be omitted (p. 32).

Laennec's mode of using this salt, and which, with some slight modification, I believe to be the best, is the following:—Immediately after bleeding give one grain of emetic tartar, dissolved in two ounces and a half of some mild fluid [cold weak infusion of orange flowers], sweetened with half an ounce of syrup of marshmallows: this is to be repeated every two hours for six times, and then suspended for seven or eight hours, if the symptoms are not urgent, or if there be any inclination to sleep. But if the disease has already made progress, or if the oppression be great, or the head affected, continue the medicine until amendment takes place; and in severe cases increase the dose to two, or two and a half grains. The only modification in this plan, which I would venture to propose, is, to begin with a somewhat smaller dose (say one-third or one-half of a grain), and gradually increase it; for in consequence of the violent vomiting which one grain has sometimes produced, I have found patients positively refuse to continue the use of the medicine.

From my own experience I should say, that emetic tartar is nearly as serviceable when it causes moderate sickness and slight purging, as when it occasions no evacuation: but many practitioners deny this. Laennec observes, that "in general the effect of emetic tartar is never more rapid, or more efficient, than when it gives rise to no evacuation; sometimes, however, its salutary operation is accompanied by a general perspiration. Although copious vomiting and purging are by no means desirable, on account of the debility and hurtful irritation of the intestinal canal which they may occasion, I have obtained remarkable cures in cases in which such evacuations had been very copious[t]." A few drops of tincture of opium may be sometimes conjoined with the antimony, to check its action on the alimentary canal.

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[n] *Dublin Hospital Reports*, v. p. 48.

[o] *Lectures on Diseases of the Lungs and Heart*, 188.

[p] Bayle, *Bibliothèque Thérapeutique*, i. 246.

[q] *Dictionnaire de Médecine*, 2de éd. iii. 220.

[r] *Recherches de la Saignée.* Paris, 1835.

[s] *Op. cit.* p. 62.

[t] *Op. supra cit.* p. 251.

The attempts which have been made to explain the *modus medendi* of emetic tartar in pneumonia and other inflammatory diseases, are most unsatisfactory. Whilst almost every writer, even Broussais, admits its efficacy in inflammation, scarcely two agree in the view taken of the mode by which its good effects are produced; as the following statement proves. Rasori explains its operation according to the principles of the theory of contra-stimulus[u], of which he may be regarded as the founder. He considers emetic tartar endowed with the power of directly diminishing the inflammatory stimulus; of destroying the diathesis, and of being, therefore, a real contra-stimulus. Broussais, Bouillaud, and Barbier, ascribe its curative powers to its revulsive or derivative action on the gastro-intestinal membrane. Laennec thinks that it acts by increasing the activity of interstitial absorption. Fontaneilles supposes that the antiphlogistic effect depends on alterations in the composition of the blood. Eberle[v] refers it to the sedative effects, first, on the nervous system, and consecutively on the heart and arteries. Teallier thinks that, like many other therapeutic agents, it influences the organism by concealed curative properties. Dr. Macartney[w] regards it as a medicine diminishing the force of the circulation, by the nausea which it occasions. These examples are sufficient to show the unsatisfactory condition of our present knowledge as to the mode by which emetic tartar produces its curative effects[x]. But this is no argument against the existence of remedial powers. Shall we deny the efficacy of blood-letting in inflammation, of mercury in syphilis, of cinchona in intermittents, of arsenic in lepra, of sulphur in scabies, of hydrocyanic acid in gastrodynia, and of a host of other remedies, simply because we cannot account for their beneficial effects? The fact is, that in the present state of our knowledge we cannot explain the *modus medendi* of a large number of our best and most certain remedial means. (I have already offered some remarks on the modus medendi of liquefacients and resolvents, at p. 196).

In *pleurisy* emetic tartar does not succeed so well as in inflammation of the substance of the lungs. "It, indeed, reduces speedily the inflammatory action," says Laennec[y], "but when the fever and pain have ceased, the effusion does not always disappear more rapidly under the use of tartar emetic than without it." I have sometimes conjoined opium (always after copious blood-letting) with advantage. In *bronchitis* (both acute and chronic) it may be most usefully employed, in conjunction with the usual antiphlogistic agents[z]. In *rheumatism* (especially the kind called *articular*), next to peripneumonia, emetic tartar has been found by some practitioners (especially by Laennec[a]), more efficacious than in any other inflammatory affection: the usual duration of the complaint, when treated by this remedy, was found by Laennec to be seven or eight days[b]. In muscular rheumatism it succeeds less perfectly. Synovial effusions (whether rheumatic or otherwise) have, in some cases, given way rapidly to the use of emetic tartar[c]. In *arachnitis*, Laennec has seen all the symptoms disappear, under the use of emetic tartar, in forty-eight hours. In three instances of acute hydrocephalus, all the symptoms disappeared in the same space of time. In *phlebitis*[d];

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[u] *Vide* p. 129.

[v] *Materia Medica*, i. 66.

[w] *A Treatise on Inflammation.* 1838.

[x] See p. 196 for some observations on the curative agency of resolvents.

[y] *Op. cit.* p. 259.

[z] *Vide* also Dr. Kemp, *Lond. Med Gaz.* xix. 300; and Mr. Ellis, *op. cit.* p. 369.

[a] *Op. cit.*

[b] See also Bayle's *Bibl. Thérap.* i. 311; and Lepelletier, *De l'Emploi du Tart. Stib.* p. 220.

[c] Laennec, *op. cit.* p. 263; and Gimelle, *Brit. and For. Med. Rev.* for July, 1838, p. 224.

[d] Laennec, *op. cit.*

in *inflammation of the mammæ*, occurring after delivery[e]; in *ophthalmia*, and various other inflammatory affections, emetic tartar has been successfully employed as an antiphlogistic.

In continued fever, it is of considerable service. Mild cases are benefitted by the use of small doses (as from one-sixteenth to one-fourth of a grain), as a diaphoretic. In the more severe form of this disease, accompanied with much vascular excitement, emetic tartar, in the dose of half a grain or a grain, may be usefully administered as an antiphlogistic; but its use should, in general, be preceded by blood-letting. In the advanced stages of typhus fever, accompanied with intense cerebral excitement, manifested by loss of sleep, delirium, &c., Dr. Graves[f] has obtained most beneficial results from the use of emetic tartar and opium. The same combination has been employed with great success in delirium tremens, as well as in delirium of erysipelas, scarlatina, and measles, by Dr. Law[g].

Emetic tartar is one of our most valuable sudorifics, being oftentimes available when other agents of this class are inadmissible: for example, when we are desirous of producing diaphoresis, in fevers and other diseases which are accompanied with preternatural vascular action about the head, the use of opiate sudorifics (as the compound ipecacuanha powder) is objectionable; whereas emetic tartar may be employed with safety, since it has no tendency to increase disorder of the nervous system, but to reduce cerebral excitement. On the other hand, when much gastric or enteritic irritation is present, the narcotic sudorifics are generally to be preferred to antimony.

As an expectorant, in various pulmonary affections, small doses of this salt are frequently employed with advantage.

In some spasmodic complaints the use of it has been followed, in the few instances in which it has been tried, with good effects[h]. In *apoplexy* it has been employed to depress cerebral vascular action, but its tendency to occasion vomiting renders it objectionable.

As a local irritant, applied to the skin, it may be employed in the form of aqueous solution, ointment, or plaster. It is used in the same cases as vesicatories, over which it has the advantage of not affecting the urino-genital organs. When it is desirable to keep up long-continued irritation, blisters are in some cases preferable. In *chronic diseases of the chest* it is used with the greatest advantage. I have found it much more serviceable than blisters, or any other kind of counter-irritant. I frequently direct one part of the chest to be rubbed until the eruption is produced; and then, after the interval of a day or two, another part; thus keeping up irritation by a succession of applications to different parts of the chest for several months. In this way it is most serviceable in chronic catarrhs, peripneumonies, and pleurisies. Even in lingering phthisis I have seen the cough and pain alleviated by the occasional use of antimonial frictions. In

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[e] Dr. E. Kennedy, Mr. Lever, and Dr. Ashwell, *Lond. Med. Gaz.* xx. 761.

[f] *Lond. Med. Gaz.* xx. 538.

[g] *Ibid.* xviii. 538 and 694.

[h] *Vide* Laennec, *op. cit.* p. 260; Jacobi, *Lond. Med. Gaz.* iii. 784; and Mr. Ackerley, *Lond. Med. Gaz.* xxi. 56.

hooping-cough it is also serviceable. Autenrieth recommended it as a means of diminishing the frequency of the paroxysms and the violence of the cough. In *laryngitis* it is occasionally of great service; as also in various *affections of the joints,* especially chronic inflammation of the capsular ligament, or of the synovial membrane, hydrops articuli, particularly when connected with inflammation, and tumors of various kinds about the joints. In *tic douloureux*[i] it has also been employed with benefit. In the *paralysis* of children the region of the spine should be rubbed with the ointment. Its effects are most beneficial, especially when one leg only is affected. It is sometimes necessary to keep an eruption out for many weeks. In *hysteria*[j] the same application to the spine has been found serviceable.

A *stimulating wash,* composed of one scruple of tartar emetic to an ounce of water, was proposed by the late Sir William Blizard, in the year 1787, to cleanse foul ulcers, repress fungous growths and venereal warts, and as an application to tinea capitis. A weak solution (as half a grain to the ounce of water) has been employed as a stimulant in chronic ophthalmia, and in spots on the cornea.

ADMINISTRATION.—The dose of emetic tartar, *in substance,* is, as a diaphoretic and expectorant, $\frac{1}{12}$ to $\frac{1}{6}$ of a grain; as a nauseant, from $\frac{1}{4}$ to $\frac{1}{2}$ a grain; as an emetic, from 1 to 2 grains; as an antiphlogistic, from $\frac{1}{2}$ a grain to 3 or 4 grains. This salt is, however, rarely employed in substance. Sometimes a grain of it, mixed with ten or fifteen grains of powdered ipecacuanha, is employed as an emetic. A mixture of one grain with sixteen grains of sulphate of potash may be employed, in doses of from two to four grains, as a substitute for antimonial powder, to promote diaphoresis.

In *solution,* it is commonly employed, as an expectorant, diaphoretic, nauseant, or emetic, in the form of antimonial wine. When used as an antiphlogistic, an aqueous solution of greater strength may be administered: it should be made with boiling distilled water in a glass vessel (as a Florence flask).

For external use, emetic tartar is employed in the form of *liniment, ointment,* or *plaster.* A saturated solution is a very useful liniment: it is prepared by pouring an ounce and a half of boiling water over a drachm of emetic tartar, and allowing the solution to stand till cold. In many cases it will be found preferable to the ointment; being the mildest, least painful, and cleanest. Another mode of employing emetic tartar externally is by sprinkling from ten grains to a drachm of the salt in fine powder over a Burgundy pitch plaster.

ANTIDOTE.—Promote vomiting by tepid bland liquids. The antidote is said to be tannic acid, and vegetable substances which contain it (as yellow bark, tea, nutgalls, &c.) Faure[k] recommends the decoction in preference to other preparations of yellow bark. But though cinchona decomposes emetic tartar it does not destroy its activity.

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[i] Hausbrandt, *British and Foreign Medical Review,* Jan. 1837, 230.
[j] Tate, *A Treatise on Hysteria.* Lond. 1830.
[k] *Lond. Med. Gaz.* xvi. 703.

Some years since, at the General Dispensary, I saw from 1 to 2 grains of this salt, mixed with either powder or decoction of yellow bark, given by Dr. Clutterbuck to nearly 100 patients: and in almost every instance nausea and vomiting occurred. The experience of Laennec[l], as well as of Rayer[m], is to the same effect. Opium is a most valuable agent for checking excessive evacuations. Venesection and the warm bath are also important means of relieving the gastro-enteritis.

1. **VINUM ANTIMONII POTASSIO-TARTRATIS**, L.; *Vinum Antimoniale*, E.; *Liquor Tartari Emetici*, D.; *Antimonial Wine.* (Emetic Tartar, ℈ij.; Sherry, Oj., *L. E.*—Emetic Tartar, ℈j.; Hot distilled Water, f℥viij.; Rectified Spirit of Wine, f℥ij.) — Each fluidounce contains two grains of emetic tartar. It is important that Sherry, and not an inferior kind of wine, be employed: for the latter frequently contains matters which precipitate the sesquioxide of antimony. If the wine be good, and the salt pure, no precipitate is formed in the solution, unless it be kept for a long period, when decomposition of the salt ensues. The Dublin formula is objectionable on account of its want of colour.

Antimonial wine is used, as a diaphoretic or expectorant, in doses of from ten to thirty drops frequently repeated; as a nauseant, from one to two fluidrachms; as an emetic, about half a fluidounce, or two fluidrachms given at intervals of about ten minutes for four or five times, or until the desired effect is produced; as an emetic for children, from thirty drops to a fluidrachm; and as an antiphlogistic in peripneumonia, from two or three fluidrachms to an ounce; but for this latter purpose an extemporaneous but carefully made aqueous solution is to be preferred.

2. **UNGUENTUM ANTIMONII POTASSIO-TARTRATIS**, L.; *Unguentum Antimoniale*, E.; *Unguentum Tartari Emetici*, D.; *Tartar Emetic Ointment.* (Emetic Tartar, rubbed to very fine powder, ℥j.; Lard, ℥iv., *L. E.*—The *Dublin College* orders ʒj. of the Emetic Tartar to ℥j. of Lard).—In the preparation of this ointment it is important that the emetic tartar be in the state of a very fine powder, in order to avoid the irritation produced by rubbing gritty particles on the skin. A portion of ointment about the size of a small nut is to be rubbed on the skin night and morning. After the use of it for two or three times, the painful condition of the part thereby induced commonly prevents further employment of friction. It is sometimes applied, spread on linen, without rubbing. By either of these methods a crop of painful pustules is produced: but the facility and rapidity with which they are developed varies considerably in different individuals. Occasionally adventitious eruptions have appeared in other parts of the body, which have been ascribed to absorption of antimony into the system[n]. But I believe with Rayer[o], that they arise from the inadvertent application of the ointment to these parts. This oint-

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[l] *Diseases of the Chest*, Forbes's Translation, 257.

[m] *Dict. de Méd. et Chir. Prat.* iii. 57.

[n] *Gaz. Méd.* 1832, p. 842.

[o] *Treat. on Diseases of the Skin*, by Dr. Willis, p. 540.

ment is used as a counter-irritant in various chronic maladies: thus it is applied to the chest in pulmonary affections, and to the joints in chronic diseases (whether rheumatic or otherwise). It should only be applied to sound portions of skin, and, therefore, leech-bites, the scarifications from cupping, wounds, &c. are to be carefully avoided; for severe inflammation, and even gangrenous ulceration, may be produced by not attending to this caution. I have before mentioned (p. 670) that in a very few cases severe and even fatal constitutional disorder has appeared to have resulted from the use of antimonial ointment.

ORDER XIX.—GOLD AND ITS COMPOUNDS.

1. AU′RUM.—GOLD.

HISTORY.—Gold has been known from the most remote periods of antiquity. It was in common use 3,300 years since[p], and was probably the first metal with which mankind was acquainted. The alchemists termed it *Sol* or *Rex metallorum.*

NATURAL HISTORY.—It is found only in the metallic state; commonly alloyed with other metals, especially with silver, tellurium, copper, and iron. It occurs in veins in primitive rocks; and is also found in alluvial deposits in small lumps or particles, called *gold dust.* It is found in several parts of Europe, Asia, and Africa, but principally in America, especially the southern part.

PREPARATION.—The mode of extracting gold varies in different places, principally according to the nature of the gangue. The ore is freed as much as possible from foreign matters, by mechanical processes (stamping, washing, &c.); and sometimes by roasting; and is then smelted with some flux, as borax, to separate the stony matters. Or it is fused with lead, and afterwards submitted to cupellation: or amalgamated with mercury, and, after straining, distilled.

The separation of gold from silver (*parting*) may be effected in the *dry way* by fusion, either with sulphur, by which metallic gold and sulphuret of silver are procured; or with sesquisulphuret of antimony, by which sulphuret of silver and an alloy of gold and antimony are procured: the last-mentioned metal may be separated by heating the alloy in the air, as well as by other methods. Gold may also be freed from silver in the *wet way* by the process of *quartation:* that is, by treating an alloy of three parts of silver and one of gold with nitric acid, which dissolves the silver; or by action of sulphuric acid (see *Cupri Sulphas*).

PROPERTIES.—The crystalline forms of native gold are the cube, the regular octohedron, and their modifications. Pure gold has a rich yellow colour, a sp. gr. of 19·2 to 19·4, is soft, very ductile, and malleable, fuses at a bright red heat (2016° F. according to Daniell), and in the liquid state has a brilliant greenish colour. Its equivalent is somewhat uncertain: Gmelin fixes on 66,—Thomson, 100,—Berzelius and Graham, 99·6,—Turner, 199·2,—and Brande, 200: I shall adopt the last.

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[p] *Exodus*, xi. 2.

Characteristics.—Gold is readily distinguished by its colour and softness, by its being unacted on by nitric acid, and by its ready solubility in nitro-hydrochloric acid. The solution is yellow, stains organic matters (as the skin) purple, throws down, by the addition of protosulphate of iron, metallic gold in the finely-divided state, by protochloride of tin a dark or black precipitate, and by protonitrate of mercury a black precipitate: heated with borax by the blowpipe it forms a pink or rose-coloured glass, but is subsequently reduced.

PHYSIOLOGICAL EFFECTS.—Gold, like other metals, has been frequently supposed to be inert while it retains its metallic condition, but in this, as well as in some other instances, the accuracy of the assumption has been denied. Both Chrestien[q] and Niel[r], as well as other writers, assert that finely-divided metallic gold (*pulvis auri*) produces the same constitutional effects as those caused by the various preparations of this metal, but in a milder degree, while it excites little or no local irritation. It is said to promote the secretions of the skin, kidneys, and salivary glands.

USES.—It has been employed as an antivenereal and antiscrofulous remedy by Chrestien, Niel, and others, with considerable success. It is said to be preferable to the other preparations of this metal in delicate and nervous subjects, females, and infants. Gold leaf (*aurum foliatum* seu *lamellatum*) is used by dentists for filling decayed teeth, and was formerly employed by apothecaries for covering pills (*ad inaurandas* seu *obducendas pilulas*).

ADMINISTRATION.—It has been administered internally in doses of from a quarter of a grain to a grain three or four times a day. Chrestien used it by way of friction on the tongue and gums. Niel employed it endermically (that is, applied it to the skin deprived of the epidermis) in the form of ointment, composed of one grain of gold and thirty grains of lard.

PULVIS AURI (Fr. Cod.) is prepared by rubbing leaf gold (*aurum in laminas exilissimas complanatum*) with sulphate of potash, sifting and washing with boiling water to remove the sulphate: or by adding protosulphate of iron to terchloride of gold, and washing the precipitate, first with water, then with dilute nitric acid.

2. AU'RI TERCHLO'RIDUM.—TERCHLORIDE OF GOLD.

PREPARATION.—In the French Codex this is ordered to be prepared by dissolving, with the aid of heat, one part of gold in three parts of of nitro-hydrochloric acid. The solution is to be evaporated until vapours of chlorine begin to be disengaged, and then allowed to crystallize.

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[q] *Sur une Nouvelle Remède dans le Traitement des Mal. Vén.* Paris, 1811.
[r] *Recherches et Observations sur les Effets des Préparations d'Or.* Paris, 1821.

Properties and Composition.—Chloride of gold is in the form of small crystalline needles, of an orange-red colour, inodorous, and having a strong, styptic, disagreeable taste. It is deliquescent, on which account it should be preserved in a well-stoppered bottle: it is soluble in water, alcohol, and ether. When heated it evolves chlorine, and is converted, first, into protochloride, and then into metallic gold, which is left in the spongy state. It reddens litmus, stains the cuticle purple, is reduced by many metals (as iron, copper, tin, zinc, &c.), by several of the non-metallic elementary substances (as phosphorus), by some metallic salts (as protosulphate of iron), and by many organic bodies (as charcoal, sugar, gum, gallic acid, extractive, &c.), all of which, therefore, are incompatible with it. Nitrate of silver occasions a precipitate of chloride of silver and oxide of gold: hydrochloric acid removes the latter[s]. Terchloride of gold consists of 1 eq. gold = 200 + 3 eqs. chlorine, 108. The before-mentioned crystals also contain hydrochloric acid: hence they are regarded by some as constituting a double chloride of hydrogen and gold.

Physiological Effects. *a. On Animals.*—Orfila[t] examined the effects of chloride of gold on animals, and infers from his experiments that when introduced into the stomach it acts as a corrosive (but with less energy than the bichloride of mercury), and destroys animals by the inflammation of the coats of the alimentary canal which it sets up.

β. On Man.—On man its effects are analogous to those of bichloride of mercury. In *small doses* it acts, according to Dr. Chrestien, more energetically as a stimulant, though less powerfully as a sialogogue, than corrosive sublimate. It promotes the secretions of the skin, the salivary glands, and the kidneys. Taken to the extent of one-tenth of a grain daily, it has occasioned violent fever. "This excitation," says Chrestien, "I regard as indispensably necessary for the cure of the diseases against which I administer gold: restrained within proper limits, it is never accompanied with any remarkable or even sensible lesion of the functions. The mouth is good, the tongue moist, the appetite continues, the bowels are not disordered, and there is ordinarily only augmentation of urine and transpiration: but if carried too far, we incur the risk of producing general erethism, inflammation of this or that organ, according to the predisposition of the patient, which will not only check the treatment, but may even induce a new disease, often more troublesome than the original one. The suspension or modification of the remedy should be governed by the unusual and sustained heat of the skin." Cullerier[u], the nephew, has seen one-fifteenth of a grain excite, at the second dose, gastric irritation, dryness of the tongue, redness of the throat, colic, and diarrhœa. When it promotes the secretion of saliva, it does not, as mercury, affect the teeth and gums[v]. Magendie[w] has seen violent gastritis, accompanied by nervous symptoms (cramps and pains in the limbs, agitation, and loss of sleep), and afterwards great heat of skin, obstinate sleeplessness, and fatiguing erections. In *large doses*, it would probably occasion symptoms analogous to those produced by the use of poisonous doses of bichloride of mercury.

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[s] For other characteristics, *vide* p. 682.

[t] *Toxicol. Gén.*

[u] Magendie, *Formulaire*, 8^{me} éd. p. 305.

[v] Grötzner, *Rust's Magazine*, B. 21, quoted by Wibmer.

[w] *Op. cit.*

Uses.—It has been employed, with variable success, as a substitute for mercury in the treatment of the secondary symptoms of syphilis. A more extended experience of it is, however, necessary to enable us to speak of its remedial powers with confidence. In the hands of Chrestien[ww], Niel[x], Cullerier[y], Legrand[z], and others, it has proved most successful.

It has also been used in scrofulous affections, bronchocele, chronic skin diseases, scirrhous tumors, &c. Duportal[a] cured with it a case of obstinate ulceration of the face, regarded by him as cancerous, and which had resisted all the ordinary methods of cure.

Legrand[b] has used chloride of gold, acidified with nitric acid, as a caustic, in syphilitic, scrofulous, and scorbutic ulcers, cancerous growths, and ulcerations of the neck of the uterus.

Administration.—Internally, it has been given in doses of one-twentieth of a grain, made into pills with starch. But as organic matters decompose it, it is better to use it in distilled water, or apply it by friction to the mouth, in quantities of from one-sixteenth to one-sixth of a grain.

Antidote.—The same as for poisoning by bichloride of mercury.

3. SO′DII AU′RO-TERCHLO′RIDUM.—AURO-TERCHLORIDE OF SODIUM.

In the French Codex this is ordered to be prepared by dissolving 85 parts by weight of terchloride of gold, and 16 parts of chloride of sodium, in a small quantity of distilled water: the solution is to be evaporated by a gentle heat until a pellicle forms, and then put aside to crystallize.

The auro-terchloride of sodium crystallizes in orange-coloured quadrangular, elongated prisms, which are permanent in the air; but when they contain any uncombined terchloride of gold, they are slightly deliquescent. They are soluble in water. When heated chlorine is evolved, and a mixture of gold and chloride of sodium is left behind. They consist of 1 eq. terchloride of gold = 308; 1 eq. of chloride of sodium = 60, and 4 eqs. of water = 36.

Its effects and uses are analogous to the terchloride of gold, over which it has the advantages of being more constant and less costly. It is exhibited internally in doses of one-twentieth to one-tenth of a grain, made into pills with starch or lycopodium. Mixed with twice its weight of orris powder or lycopodium, it may be used in frictions on the tongue and gum. An ointment (composed of one grain to thirty-six grains of lard) may be applied, endermically, to the skin, deprived of its epidermis by a blister.

[ww] *Op. cit.*
[x] *Op. cit.*
[y] *Dict. des Sciences Méd.* xxxvii. art. *Or.*
[z] *De l'Or, de son Emploi dans le Traitement de la Syphilis.* Paris, 1832.
[a] *Ann. de Chimie*, lxxviii. 55.
[b] *Lond. Med. Gaz.* xx. 414.

4. AURI TEROX'YDUM.—TEROXIDE OF GOLD.

This substance, sometimes called *peroxide of gold* or *auric acid*, is ordered, in the French Codex, to be prepared by boiling 4 parts calcined magnesia with 1 part terchloride of gold and 40 parts of water. Then wash, first with water, to remove the chloride of magnesium, afterwards with dilute nitric acid, to dissolve the excess of magnesia.

Teroxide of gold is brown; in the state of hydrate, reddish yellow. It is reduced by heat and solar light. It is insoluble in water, but is soluble in hydrochloric acid (forming terchloride of gold), and in alkalis (forming aurates). It consists of 3 equivalents oxygen, 24 + 1 eq. gold = 200.

It is used internally, in venereal and scrofulous diseases, in doses of from one-tenth of a grain to a grain, made into the form of pills with extract of mezereon.

1. **AURATE OF AMMONIA.** *Ammoniuret of Teroxide of Gold; Fulminating Gold.*—This is prepared by adding ammonia to a solution of chloride of gold. It is a yellowish-brown powder, which explodes when heated to 400°. It has been employed in the same cases as the preceding compounds, as well as in fevers, nervous affections, &c. In some cases it has produced very serious, and even fatal, results[c].

2. **PURPURA MINERALIS CASSII.** *Purple of Cassius; Aurum Stanno paratum*, Fr. Cod.—The nature of this compound is so imperfectly known, that it is impossible at present to assign to it its proper chemical name. Its active principle is probably oxide of gold. There are several methods of preparing it: the simplest is to add a solution of the mixed protochloride and perchloride of tin to a solution of terchloride of gold, until a precipitate is no longer produced. Filter and dry the precipitate.

The purple of Cassius is soluble in ammonia, and does not form an amalgam with mercury: hence it does not appear to contain any metallic gold. Its composition varies according to the mode of procuring it. Gold, oxygen, and tin, are its essential constituents.

This preparation is used in the same cases as the other preparations of gold.

5. AU'RI IO'DIDUM.—IODIDE OF GOLD.

This is ordered to be prepared, in the French Codex, by adding a solution of iodide of potassium to a solution of chloride of gold. Double decomposition takes place, and iodide of gold falls down.

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[c] Plenck, *Toxicologia*, ed. 2^{nda}, 230.

This is to be collected on a filter, and washed with alcohol, to remove the excess of iodine which precipitates with it.

Iodide of gold is of a greenish-yellow colour, insoluble in cold water, but slightly soluble in boiling water. Heated in a crucible it evolves iodine vapour, and is converted into metallic gold. It is probably composed of 1 eq. iodine = 126, and 1 eq. gold = 200.

It has been employed internally, in venereal affections, in doses of from one-fifteenth to one-tenth of a grain. Externally it has been applied in the form of ointment to venereal ulcers[c].

6. AU'RI TERCYAN'IDUM.—TERCYANIDE OF GOLD.

The directions for preparing this salt, in the French Codex, are somewhat diffuse. The process consists essentially in very carefully adding a solution of pure cyanide of potassium to a solution of chloride of gold, until a precipitate (*cyanide of gold*) ceases to be formed. The chloride of gold, prior to solution, should be deprived of all excess of acid by heating it in a salt-water bath.

Cyanide of gold is a yellow powder, which is insoluble in water. It consists, probably, of 3 eqs. cyanogen = 78, and 1 eq. gold 200. It has been used in venereal and scrofulous affections, both externally and internally. The dose is from one-fifteenth to one-tenth of a grain, made into a pill, with some inert powder.

ORDER XX.—SILVER AND ITS COMPOUNDS.

1. ARGEN'TUM, *L. E. D.*—SILVER.

History.—Silver, like gold, has been known from the most remote periods of antiquity, being mentioned in the earliest books of the Old Testament[cc]. It was termed by the alchemists and astrologers *Diana* or *Luna*.

Natural History.—It is found in the mineral kingdom in various states; sometimes nearly pure; or alloyed with other metals (especially gold, antimony, tellurium, arsenicum, and copper); or combined with sulphur, selenium, iodine, or chlorine. Of these, native silver and the sulphuret are by far the most abundant. A native carbonate of silver is described, but is exceedingly rare.

Preparation.—The processes followed for the extraction of silver vary in different places, according to the nature of the ore: they are principally *amalgamation* and *cupellation*. At Freyberg the ore is mixed with common salt, and roasted, by which the sulphuret of silver is converted into the chloride of this metal: water and iron are then added, to remove the chlorine, and the disengaged silver is finally dissolved in mercury (*amalgamation*), and the solution submitted to distillation, by which the mercury is volatilized, and the silver left behind[d]. The process of amalgamation followed in America is somewhat different[e].

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[c] Pierquin, *Journ. de Progrès.*

[cc] *Genesis*, xliv. 2; *Job*. xxii. 25.

Silver is obtained from argentiferous galena, as follows:—The ore is first roasted to expel the sulphur, and afterwards smelted with charcoal. The argentiferous lead is then submitted to cupellation, by which the lead becoming oxidized, is partly volatilized, and partly sinks into the cupel (*cineritium*), leaving the silver[f].

Pure silver is obtained by immersing a copper rod in a solution of the nitrate. The precipitate is to be digested in caustic ammonia, to remove all traces of copper, and afterwards washed with water.

Properties.—In the native state, silver occurs crystallized in the cube and regular octohedron. When pure this metal is white, with a slight shade of yellow; inodorous and tasteless. It is moderately hard and elastic; very ductile and malleable: a single grain may be drawn out into 400 feet of wire, and leaf silver (*argentum in laminas extensum; argentum foliatum*) may be procured, whose thickness is only $\frac{1}{100000}$ of an inch. Its sp. gr. is 10·474. It melts at a bright red heat (1873° F. according to Daniell). When exposed to the air it does not oxidate, but readily tarnishes by sulphurous vapours. Its equivalent is 108.

Characteristics.—It is soluble in nitric acid.—(For the characteristics of the nitric solution, see p. 689.)

Purity.—The silver of the shops usually contains traces of gold and copper.

It is totally dissolved by diluted nitric acid. This solution, on the addition of chloride of sodium, throws down a precipitate, which an excess of ammonia dissolves, and it should be free from colour. The chloride of silver being removed, and hydrosulphuric acid added to the solution, it is not coloured by it, and nothing is thrown down. The specific gravity of silver is 10·4. *Ph. L.*

Soluble entirely in diluted nitric acid: this solution, treated with an excess of muriate of soda, gives a white precipitate entirely soluble in aqua ammoniæ, and a fluid which is not affected by sulphuretted hydrogen. *Ph. Ed.*

Physiological Effects.—Silver in the metallic state is totally inert. It may remain for many months in the alimentary canal without exciting any ill effects[g]. Colic, however, has been ascribed to the handling of silver[h].

Uses.—In pharmacy it is used for the preparation of the nitrate, which is employed as a medicine and as a test.

Silver leaf is used for filling the hollows of decayed teeth, and was formerly employed to cover pills. An amalgam of silver is also used by some dentists for stopping teeth. It is objectionable on account of its becoming black by the sulphuretted or phosphuretted hydrogen evolved by the breath.

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[d] J. H. Vivian, in Taylor's *Records of Mining*, p. 21.

[e] Boussingault, *Annales de Chimie*, li. 337; also, Ward, *Mexico in* 1827, vol. ii. 437.

[f] On the smelting processes of Hungary, Saxony &c., consult Taylor's *Records of Mining*, p. 51.

[g] *Lond. Med. Gaz.* May 20, 1837.

[h] *Journal de Chimie Médicale*, t. vi. 2$^{\text{nde}}$ Séries, 1840.

2. ARGEN'TI NI'TRAS, *L. E.*—NITRATE OF SILVER.

(Argenti Nitratis Crystalli; and Argenti Nitras fusum, *D.*)

HISTORY.—Geber[1] describes the method of preparing crystallized nitrate of silver. When this salt is fused, it is termed *Lunar Caustic* (*Causticum Lunare*). The term *Infernal Stone* (*Lapis Infernalis*) is sometimes applied to this salt as well as to hydrate of potash (see p. 481). Nitrate of silver is sometimes called *Argentum Nitratum.*

PREPARATION.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Silver, ℥iss.; Nitric Acid, f℥j.; Distilled Water, f℥ij. Mix the nitric acid with the water, and dissolve the silver in them in a sand-bath. Afterwards increase the heat gradually, that the nitrate of silver may be dried. Melt this in a crucible, with a slow fire, until, the water being expelled, ebullition has ceased; then immediately pour it into proper moulds.

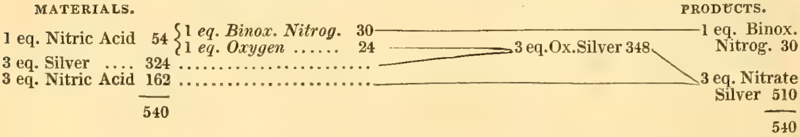
The directions of the *Edinburgh College* are essentially similar, except that the salt is ordered to be fused in an earthenware or porcelain crucible, and the fused matter poured into iron moulds previously heated and greased slightly with tallow. Preserve the product in glass vessels.

The *Dublin College* directs two forms of nitrate of silver to be prepared; the one in crystals, the other fused. The *crystallised* nitrate is prepared of silver laminated and cut into small fragments, *thirty-seven* parts; Diluted Nitric Acid, *sixty parts.* Let the silver be passed into a glass vessel, and let the acid, previously diluted with water, be poured on it. Dissolve the metal with a heat gradually increased; then, by evaporation and refrigeration, let crystals be formed, to be dried without heat, and to be preserved in a glass vessel placed in darkness.

The following are directions for preparing the *fused* nitrate:—Let Silver be dissolved in Diluted Nitric Acid as above described; then let the liquor be evaporated to dryness. Let the remaining mass, passed into a crucible, be liquefied by a slow heat. Let it then be poured into proper moulds, and preserved in a glass vessel.

The fusion may be more readily and safely effected in a Berlin porcelain capsule over a spirit or gas lamp, by means of Griffin's lamp furnace, than in a crucible over a slow fire, as directed in the London Pharmacopœia. It is unnecessary and objectionable to grease the moulds, as directed by the Edinburgh College.

The *theory* of the process is readily comprehended. Three equivalents or 324 parts of silver abstract three equivalents or 24 parts of oxygen from one equivalent or 54 parts of nitric acid, thereby disengaging one equivalent or 30 parts of binoxide of nitrogen, and forming three equivalents or 348 parts of oxide of silver, which unite with three equivalents or 162 parts of nitric acid to form three equivalents or 510 parts of nitrate of silver.



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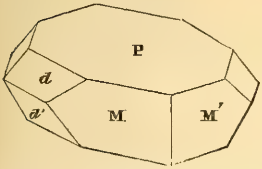
[1] *Invention of Verity*, ch. xxi.

PROPERTIES.—Nitrate of silver forms transparent, colourless, right rhombic prismatic crystals. Its taste is strongly metallic and bitter. When heated it fuses: if the temperature be increased, decomposition ensues; and metallic silver is obtained. The fused nitrate forms on cooling a whitish, striated mass, having a crystalline texture. The salt is soluble in both water and spirit. It does not deliquesce: when exposed to the atmosphere and solar light it blackens, probably from the action of organic matter, or hydrosulphuric acid, contained in the atmosphere. Mr. Scanlan[j] finds that nitrate of silver in a clean dry glass tube, hermetically sealed, undergoes no change of colour by exposure to solar light: the contact of organic matter, however, readily occasions it to become black. A solution of nitrate in pure distilled water is unchanged by exposure to solar light; but the presence of organic matter causes the liquid to become black or reddish. (See pp. 257, 258, and 259).

FIG. 118.



Crystal of Nitrate of Silver.

Characteristics.—It is known to be a *nitrate* by its deflagration when heated on charcoal, and the evolution of nitrous fumes, as well as by the other characters before mentioned for this class of salts (see p. 289). Its characters as a *salt of silver* are as follows:—It yields with hydrochloric acid a white precipitate (*chloride of silver*), whose properties have been before stated (see p. 226). It forms also, with solutions of the alkaline carbonates, oxalates, and ferrocyanides, white precipitates (*carbonate, oxalate, and ferrocyanide of silver*). With solutions of the alkaline arsenites and phosphates it yields yellow precipitates (*arsenite and subsesquiphosphate of silver*); red with the arseniates (*arseniate of silver*); and with lime water or the fixed alkalis olive-brown (*oxide of silver*). Phosphorus and metallic copper each precipitate crystals of metallic silver from the aqueous solution of this salt. Hydrosulphuric acid occasions a black precipitate (*sulphuret of silver*).

COMPOSITION.—Nitrate of silver is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Proust.*
Oxide of Silver	1	116	68·23	69·5
Nitric Acid	1	54	31·76	30·5
Nitrate of Silver	1	170	99·99	100·0

PURITY.—Nitrate of silver should be white, and completely soluble in distilled water. By the action of organic matters and light it blackens from a partial reduction. The presence of copper may be detected in its solution by the blue colour produced with caustic ammonia. The watery solution from which the silver has been thrown down by hydrochloric acid, should be unchanged by the addition of hydrosulphuric acid, showing the absence of lead and copper; and be completely volatilized by heat: if any saline residuum be obtained, the nitrate was adulterated. A chemical manufacturer informs me, that he has detected 10 per cent. of nitrate of potash in the nitrate of silver of commerce. It was recognised by precipitating the silver by means of hydrochloric acid, and subsequently crystallizing the nitrate of potash. The white precipitate produced with either hydrochloric acid or chloride of sodium should be readily dissolved by caustic ammonia: if chloride of lead be present the effect will be otherwise.

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[j] *Athenæum*, August 25, 1838.

It is originally white, but blackens by exposure to light. It is entirely soluble in water. Copper put into the solution precipitates silver; its other properties are as above detailed respecting silver. *Ph. Lond.*

Soluble in distilled water, with the exception of a very scanty black powder: twenty-nine grains dissolved in one fluidounce of distilled water, acidulated with nitric acid, precipitated with a solution of nine grains of muriate of ammonia, briskly agitated for a few seconds, and then allowed to rest a little, will yield a clear supernatant liquid, which still precipitates with more of the test. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Orfila[k] found that it acted on animals as a powerfully corrosive poison. When dogs were made to swallow it, gastro-enteritis was induced. No symptoms indicating its absorption were observed. Dissolved in water, and thrown into the jugular vein, it produced difficult respiration, convulsive movements, and speedy death.

β. On Man.—The *local action* of nitrate of silver is that of a caustic or corrosive. This might be expected, from observing its action on albumen and fibrin—substances which form the principal part of the animal textures. If a solution of nitrate of silver be added to an albuminous liquid, a white curdy precipitate is formed, composed[l] of *albumen* 84·5, and *nitrate of silver* 15·5. This precipitate is soluble in caustic ammonia, and in solutions of nitrate of silver, albumen, and chloride of sodium. After some time it becomes coloured and ultimately blackish, from the partial or complete reduction of the silver. The action of nitrate of silver on milk[m], as well as on fibrin, is analogous to that on albumen; that is, a white compound of nitrate of silver and of these organic substances is at first formed, but gradually the metal is reduced. These facts assist us in comprehending the nature of the changes produced by the application of nitrate of silver to the different tissues[n].

Applied to the skin it produces first a white mark, owing to its union with the coagulated albumen of the cuticle: gradually this becomes bluish-grey, purple, and ultimately black, owing to the partial reduction of the silver. If the integument be moistened, and the nitrate applied three or four times, it causes at the end of some hours vesication, which is usually attended with less pain than that produced by cantharides. In some cases it excites acute pain. In one instance in which I applied it freely to the scalp for a cutaneous affection, fever with delirium was produced, which endangered the life of the patient (a girl of six years). This is deserving of notice, because in Mr. Higginbottom's work[o] we are told, that nitrate of silver applied as a vesicant "causes scarcely any constitutional irritation, even in children." In a few days the black and destroyed cuticle cracks and falls of, without any destruction of the subjacent cutis vera.

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[k] *Toxicol. Gén.*

[l] Lassaigne, *Journ. de Chim. Méd.* t. vi. IIe Série, p. 306.

[m] Dr. C. G. Mitscherlich, *Pharmaceutisches Central-Blatt für* 1839, S. 447.

[n] See some remarks of Mulder on the action of metallic salts on fibrin and albumen, in the *Pharmaceutisches Central-Blatt für* 1838, S. 515.

Applied to the hair or nails the nitrate stains them black, as in the case of the cuticle; and, in consequence, it is one of the substances employed as a *hair dye* (see p. 218). When recently applied, the black tint of the hair, and even of the cuticle, may be removed by washing with a solution of chloride of sodium, and then with ammonia-water, to dissolve the chloride of silver which is produced[p]. To detect silver in stained hair, the latter is to be treated with chlorine, by which chloride of silver is produced, which is soluble in ammonia, and precipitable from its solution by nitric acid[q]. Part of the black colour of the hair stained by the nitrate depends on the formation of sulphuret of silver.

When nitrate of silver is applied to an ulcer it produces a white film (owing to its union with the albumen, and perhaps also with the chloride, of the secretion). This film in a few hours assumes a dark colour, and ultimately forms a black eschar. This hardens, and in a few days becomes corrugated, separates at the edges, and at length peels off altogether, leaving the surface of the sore beneath in a healed state[r]. The intensity of the pain varies much in different cases; but it is, on the whole, very much less than might be imagined by those who have not tried this remedy.

When applied to mucous membranes, a similar white compound of the nitrate with the animal matter of the secreted mucus is formed, and this defends the living tissue from the action of the caustic, so that the effects are not so violent as might be expected. Thus the solid nitrate may be applied to the mucous surface of the vagina, and even to the os uteri, in cases of leucorrhœa and gonorrhœa, oftentimes without exciting any pain or inflammation: in some instances, however, it produces smarting pain, which lasts for several hours, but no serious effects have resulted from its use, even when, by accident, two drachms of nitrate have been left to dissolve in the vagina[s].

Its chemical effects on the other mucous membranes are analogous to those just mentioned; but the pain which it produces varies with different membranes, and in the same membrane under different states. Its application to the conjunctiva is attended with acute pain (especially when inflammation is going on), though in general this soon subsides. On all these surfaces it acts as an astringent.

The safety with which, in most cases, large doses of the nitrate are administered internally, must depend on the presence of the mucus which lines the internal coat of the stomach, and on chlorides and free hydrochloric acid contained in this viscus. These form with the nitrate new compounds (*albuminate* and *chloride*), less energetic in their local action than the nitrate. It is deserving of especial notice that larger doses may be exhibited without inconveniencing the stomach, in the form of pill, than in that of solution; in consequence, I presume, of the latter acting on a larger surface. Dr. Powell[t], in some cases, was enabled to give 15 grains at a dose in the form of pills, while he rarely found stomachs that could bear more than five grains in solution. Fouquier[u] has also remarked the greater activity of the solution. If cautiously exhibited, beginning with small doses and gradually increasing them, it may be exhibited for a considerable period without producing any obvious changes in the corporeal functions, though it may be exercising a beneficial influence over the constitution, evinced by its amelioration of certain diseases, as epilepsy. In some cases it has caused an eruption[v]. If the dose be too large it occasions gastrodynia, sometimes nausea and vomiting, and occasionally purging, Taken in an excessive dose it acts as a corrosive poison; but cases of this kind are very rarely met with. Boerhaave mentions an instance in which it caused excruciating pain, gangrene, and sphacelus of the first passage.

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[o] *Essay on the Use of the Nitrate of Silver*, 2d ed. p. 198.

[p] *Journ. de Chim. Méd.* vii. 542.

[q] Devergie, *Méd. Lég.* ii. 933.

[r] Higginbottom, *op. cit.* p. 10.

[s] Dr. Hannay, *Lond. Med. Gaz.* xx. 185; also Mr. Bell, *ibid.* 473; and Dr. Jewell, *Pract. Observ. on Leucorrhœa.*

All the above-mentioned effects are referrible to its local action, and from them we have no evidence of its absorption, or of the nature of its influence over the general system. But the discoloration of the skin, presently to be noticed, fully proves that absorption does take place when the medicine is exhibited in small but long-continued doses. It exercises a specific influence over the nervous system; at least I infer this, partly from the effects observed by Orfila when it was injected into the veins of animals, and partly from its occasional curative powers in affections of this system, as epilepsy and chorea.

The blueness, or slate colour, or bronze hue of the skin just alluded to, has been produced in several patients who have continued the use of the nitrate during some months or years[w]. In some of the cases the patients have been cured of the epilepsy for which they took the medicine; in others the remedy has failed[x]. In one instance which fell under my notice, the patient, a highly respectable gentleman, residing in London, was obliged to give up business in consequence of the discoloration; for when he went into the street, the boys gathered around him, crying out "There goes the blue man." In this instance no perceptible diminution of the colour had occurred for several years, but in some cases it fades in intensity. The corion is the essential seat of it. Dr. Baddeley[y] found that blisters rose white,—a proof that in his patient the colouring matter was below the epidermis. But in some instances the cuticle and corpus mucosum of the face and hands participate in the tint. In one instance the mucous membrane of the stomach and intestines was similarly tinted. A case is mentioned by Wedemeyer[z] of an epileptic who was cured by nitrate of silver, but eventually died of diseased liver and dropsy: all the internal viscera were more or less blue, and Brande, a German chemist, obtained metallic silver from the plexus choroides and pancreas. The discoloration of the skin is usually regarded as permanent and incurable; but I have been informed that in one instance washes of dilute nitric acid diminished it. If this observation be correct, I would suggest the exhibition of nitric acid internally, as well as its external use. Dr. A. T. Thomson[a] suggests that if nitric acid were conjoined with nitrate of silver the discoloration might be prevented; and the suggestion certainly deserves attention. But I would observe, that if the acid should prove efficacious, his hypothesis, that the colour depends on blackened chloride of silver, will be disproved; for nitric acid can neither prevent the action of the compounds of chlorine on the salts of silver, nor can it dissolve the white chloride or the black subchloride.

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[t] *Med. Trans. of the College of Phys.* iv. 85.
[u] *Dict. Mat. Med.* i. 403.
[v] Sementini, *Quart. Journ. of Science*, xii. 189; Copland, *Dict. Pract. Med.* i. 68.
[w] *Medico-Chirurg. Trans.* vii. and ix.
[x] Rayer, *Treatise on Skin Diseases, by Willis*, 961.
[y] *Med.-Chir. Trans.* ix. 238.

USES.—Nitrate of silver has been employed *internally* in a very few cases only; and of these the principal and most important are epilepsy, chorea, and angina pectoris. Its liability to discolour the skin is a great drawback to its use; indeed, I conceive that a medical man is not justified in risking the production of this effect without previously informing his patient of the possible result. Dr. Osborne[b] ascribes its good effects to its allaying irritation of the gastric membrane. But in a large number of instances the asserted existence of this irritation is a mere assumption, perfectly devoid of proof.

In *epilepsy* it has occasionally, perhaps more frequently than any other remedy, proved successful. Drs. Sims[c], Baillie, R. Harrison, Roget, and J. Johnson[d], have all borne testimony to its beneficial effects. Its *methodus medendi* is imperfectly understood. This, indeed, is to be expected, when it is considered that the pathology and causes of epilepsy are so little known; and that, as Dr. Sims has justly observed, every thing concerning this disease is involved in the greatest doubt and obscurity, if we except the descriptions of a single fit, and that it returns at uncertain intervals. In this state of ignorance, and with the already-mentioned facts before us, as to the curative powers of this salt, the observation of Georget[e], that he has great difficulty in conceiving how the blindest empiricism should have led any one to attempt the cure of a diseased brain by cauterizing the stomach, is, I conceive, most absurd and unwarranted. The cases which have been relieved by it are probably those termed by Dr. M. Hall[f] eccentric. In the few instances in which I have seen this remedy tried, it has proved unsuccessful; but it was not continued long, on account of the apprehended discoloration of the skin.

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[z] *Lond. Med. Gaz.* iii. 650.
[a] *Elem. of Mat. Med.* i. 715.
[b] *Dublin Med. Journ.* Jan. 1839.
[c] *Mem. of the Med. Soc. of Lond.* iv. 379.
[d] *Treat. on Nerv. Dis.* by J. Cooke, M.D. ii. Pt. 2, 147.
[e] *Physiol. du Système Nerv.* ii. 401.
[f] *Lect. on the Nerv. System,* p. 143.

In *chorea* it has been successfully employed by Dr. Powell[g], Dr. Uwins[h], Dr. Crampton[i], Lombard[j], and others. In *angina pectoris* it has been administered in the intervals of the paroxysms with occasional success by Dr. Cappe[k] and Dr. Copland[l].

In *chronic affections of the stomach* (especially morbid sensibility of the gastric and intestinal nerves) it has been favourably spoken of by Autenreith[m], Dr. James Johnson[n], and Rueff[o]. It has been employed to allay chronic vomiting connected with disordered innervation, as well as with disease of the stomach (scirrhus and cancer), and to relieve gastrodynia. The foregoing are the most important of the diseases against which nitrate of silver has been administered internally

As an *external agent* its uses are far more valuable, while they are free from the danger of staining the skin. It is employed sometimes as a *caustic*, and as such it has some advantages over potassa fusa and the liquid corrosives. Thus, it does not liquefy by its application, and hence its action is confined to the parts with which it is placed in contact. It is used to remove and repress spongy granulations in wounds and ulcers, and to destroy warts, whether venereal or otherwise. It is applied to chancres on their first appearance, with the view of decomposing the syphilitic poison, and thereby of stopping its absorption, and preventing bubo or secondary symptoms. This practice has the sanction of Mr. Hunter. I have several times seen it fail, perhaps because it was not adopted sufficiently early. The nitrate should be scraped to a point, and applied to every part of the ulcer. This mode of treating chancres has been recently brought forward by Ratier[p] as if it were new, and as forming part of Bretonneau's *ectrotic* (*ectrotica*, ἐκτιτρώσκω, *I abort*,) method of treating diseases!

The application of nitrate of silver to *punctured wounds* is often attended with most beneficial effects, as Mr. Higginbottom[q] has fully proved. It prevents or subdues inflammatory action in a very surprising manner. It is equally adapted for poisoned as for simple wounds. To promote the healing of *ulcers* it is a most valuable remedy. In large indolent ulcers, particularly those of a fistulous or callous kind, it acts as a most efficient stimulant. To small ulcers it may be applied so as to cause an eschar, and when at length this peels off, the sore is found to be healed. Mr. Higginbottom[r] asserts that " in every instance in which the eschar remains adherent from the first application, the wound or ulcer over which it is formed invariably heals." Dry lint will, in general, be found the best dressing for sores touched with the nitrate.

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[g] *Medical Transactions of the College of Physicians*, iv. 85.

[h] *Edinb. Med. and Surg. Journ.* viii. 407.

[i] *Transactions of the King and Queen's College of Physicians*, iv. 114.

[j] *Rust's Magaine*, xl.

[k] *Duncan's Annals of Med.* iii.

[l] *Op. cit.*

[m] Dierbach's *Neust. Entdeck. in d. Mat. Med.* 1837. i. 528.

[n] *On Indigestion*, 2d edit. p. 87.

[o] Dierbach, *op. cit.*; also *American Journal of Medical Science*, May 1837, p. 225.

[p] *Arch. Gén. de Méd.* xv. 47 ; and xvi. 62.

[q] *Op. cit.*

[r] *Op. cit.* p. 11.

Nitrate of silver was proposed by Mr. Higginbottom as a topical remedy for external inflammation. It may be applied with great advantage to subdue the inflammatory action of erythema, of paronychia or whitlow, and of inflamed absorbents. In some cases it is merely necessary to blacken the cuticle; in others, Mr. Higginbottom recommends it to be used so as to induce vesication. In erysipelas nitrate of silver is used by many surgeons as a cautery both to the inflamed and the surrounding healthy parts. But I have so often seen the disease continue its course as if nothing had been done that I have lost confidence in its efficacy[s]. I have found tincture of iodine (see p. 246) much preferable.

Bretonneau and Serres[t] recommend the *cauterization of variolous pustules* by nitrate of silver, in order to cut short their progress. It is principally useful as a means of preventing pitting, and should be employed on the first or second day of the eruption. The solid caustic is to be applied to each pustule after the apices have been removed. This ectrotic method has also been employed in the treatment of *shingles* (herpes zoster): in one case the disease was cured in a few hours[u]. Some good rules for its application have been laid down by Rayer[v].

In some diseases of the eye nitrate of silver is a most valuable remedial agent. It is used in the solid state, in solution, and in ointment: the solution may be used as a wash or injection, or applied by a camel's hair pencil. In deep ulcers of the cornea, a cone of the solid nitrate should be applied,—in superficial ones, a solution (of from 4 to 10 grains of the salt to an ounce of distilled water) may be employed[w]. There is one drawback to the use of this substance in ulcers of the cornea, as well as other affections of the eye: viz. the danger of producing dark specks in the cornea, or of staining the conjunctiva[x]; but this occurrence is certainly very rare. Velpeau[y] has employed it in many hundred cases without ever observing such an effect. In both acute and chronic ophthalmia, Mr. Guthrie[z] employs this salt in the form of ointment (Arg. Nitr. gr. ij. ad gr. x.; Liq. Plumbi Subacet. gtt. xv.; Ung. Cetacei, ℥j.) Of this he directs a portion (varying in size from a large pin's head to that of a garden pea) to be introduced between the lids by the finger or a camel's hair pencil. It causes more or less pain, which sometimes lasts only half an hour, at others till next day. Warm anodyne fomentations are to be used; and the application of the ointment repeated every third day. In acute cases, two or three applications will arrest the disease. With this treatment, blood-letting, and the use of calomel and opium, are preceded or conjoined[a]. While many surgeons hesitate to use nitrate of silver in the first stage of acute purulent ophthalmia, all are agreed as to its value in the second stage of the disease, as well as in chronic ophthalmia. Besides the diseases of the eye already mentioned, there are many others in which the oculist finds this salt of the greatest service, as a caustic, astringent, or stimulant[b].

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[s] See also some remarks by Velpeau, in *Lond. Med. Gaz.* Aug. 21, 1840, p. 828.

[t] *Arch. Gén. de Méd.* viii. 220 and 427.

[u] *Arch. Gén. de Med.* xviii. 439.

[v] *Treatise on Skin Diseases*, by Willis, p. 260.

[w] Mackenzie, *On the Diseases of the Eye*, 2d edit. 578; also Velpeau, *Lond. Med. Gaz.* Oct. 1839.

[x] Jacob, *Dublin Hospital Reports*, v. 365.

[y] *Op. supra cit.* p. 107.

[z] *Lond. Med. and Phys. Journ.* lx. 193; lxi. 1.

In *inflammatory affections and ulcerations of the mucous membrane of the mouth and fauces*, nitrate of silver is sometimes a most valuable application[c]. When the fibrinous exudation of croup commences on the surface of the tonsils and arches of the palate, its further progress may be stopped, according to Mr. Mackenzie[d], by the application of a solution composed of a scruple of nitrate of silver and an ounce of distilled water. The solid nitrate has been introduced through an aperture in the trachea, and applied to ulcers on the inner surface of the larynx, in a case of phthisis laryngea, with apparent benefit[e].

In some forms of *leucorrhœa* the application of nitrate of silver, either in the solid state or in solution, is attended with beneficial effects. This practice was first recommended by Dr. Jewel[f]. It is, I believe, most successful in cases dependent on local irritation or subacute inflammation, and not arising from constitutional debility. The solution may be applied by a piece of lint or sponge, or may be injected by means of a syringe with a curved pipe. Its strength must vary according to circumstances. Dr. Jewel generally employed three grains of the nitrate to an ounce of water; but in the Lock Hospital, solutions are sometimes used containing half a drachm or even two scruples to the ounce. In some cases the solid nitrate has been applied to the cervix uteri and vagina by means of a silver tube. In *gonorrhœa of the female* a solution of the nitrate of silver, or even this caustic in the solid state, has been used with the best effects. It was first employed by Dr. Jewel, but subsequently, and on a much more extended scale, by Dr. Hannay[g], and without any injurious consequences. In many cases the discharge ceased, never to return, in twenty-four hours. The fear of ill effects has prevented the general adoption of this practice. In *gonorrhœa of the male*, the introduction of a bougie, smeared with an ointment of nitrate of silver, is, occasionally, a most effectual cure: but the practice is dangerous. In one case I saw acute and nearly fatal urethritis brought on by its employment. The patient was a dresser at one of the London hospitals, and had practised this mode of treatment in many instances on the hospital patients with the happiest results. An aqueous solution of the salt has been successfully used in chronic gonorrhœa[h].

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[a] For some judicious remarks on this practice, consult the article *Ophthalmia*, by Dr. Jacob, in the *Cyclop. of Pract. Med.* iii. 201.

[b] Vide Dr. Mackenzie's *Treatise on Diseases of the Eye;* and Mr. Ryall's paper, in the *Trans. of the King and Queen's College of Phys. of Ireland*, v. 1.

[c] Hunt, *Lond. Med. Gaz.* xiii. 129.

[d] *Edinb. Med. and Surg. Journ.* xxiii. 294.

[e] Liston, *Elements of Surgery*, part ii. p. 256.

[f] *Practical Observations on Leucorrhœa*, 1830.

[g] *Lond. Med. Gaz.* xx. 185.

In *fissured or excoriated nipples* the application of the solid nitrate of silver is of great service. It should be insinuated into all the chaps or cracks, and the nipple afterwards washed with tepid milk and water[i].

The application of solid nitrate of silver is a most effectual remedy for the different forms of *porrigo* which affect the heads of children. The caustic should be well rubbed into the parts. I have never known the practice to fail, or to cause the loss of hair. Where the greater portion of the scalp is involved, the different spots should be cauterized successively at intervals of some days; for, as already mentioned, I have seen fever and delirium produced in a child from the too extensive use of the remedy. In *psoriasis* the same medicine was found by Dr. Graves[j] most effectual. An aqueous solution of the nitrate is also valuable as an astringent wash in other skin diseases, as *impetigo*. The solid nitrate is sometimes employed to stop the progress of irritative or erysipelatous inflammation, by applying it in a circular form around, and at a little distance from, the inflamed portion; but I have frequently observed the inflammation extend beyond the cauterized part. Mr. Higginbottom[k] reports favourably of the effects of applying the nitrate to *burns* and *scalds;* and his observations have been confirmed by those of Mr. Cox[l].

In strictures of the urethra and œsophagus, bougies armed with lunar caustic in their points (*the caustic* or *armed bougie*) are occasionally employed with great advantage, at least in urethral stricture. When the common bougie (*cereolus simplex*) is formed, the point of it should be heated with a conical piercer, and the caustic introduced while the composition is quite soft. The point of the bougie should then be rubbed smooth on a piece of polished marble till no inequality in the size of it appear[m]. Notwithstanding that the application of nitrate of silver to stricture of the urethra has been advocated by Mr. Hunter, Sir E. Home, Mr. Wilson, Dr. Andrews, and others, it is now but little employed; yet of its efficacy and safety in many obstinate cases, where the simple bougie fails, I am assured by repeated observation. It is commonly supposed that it acts by burning or destroying the stricture: such is not the fact. It induces some change in the vital actions of the part, which is followed by relaxation of the narrowed portion of the canal, but which change is as difficult to explain as is the subduction of external inflammatory action by the application of this salt. Of the use of the caustic bougie in stricture of the œsophagus I have no experience.

Administration.—Nitrate of silver may be exhibited in doses of one-sixth of a grain, gradually increased to three or four grains, three times a-day. As before mentioned, Dr. Powell has augmented the dose to fifteen grains. The usual mode of administering it is in the form of pills made of bread-crumb; but the chloride of sodium, which this contains, renders it objectionable: some mild vegetable powder with mucilage is preferable. Common salt or salted foods should not be taken either immediately before or after swallowing these pills. Dr. Johnson[n] asserts "that there is no instance on record where the complexion has been affected by the medicine when restricted to three months' administration." It is advisable, however, not to continue the use of it beyond a month or six weeks at a time.

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[h] Rognetta, *Lancette Française*, Mar. 31, 1836.
[i] *Lond. Med. Gaz.* v. 207; xiv. 674, 719, and 754.
[j] *Lond. Med. Gaz.* vii. 520.
[k] *Op. cit.*
[l] *Lond. Med. Gaz.* x. 687.
[m] Dr. Andrews, *Observ. on the Applic. of Lunar Caustic to Strictures,* 1807, p. 126.

For external use an aqueous solution is employed of strengths varying from a quarter of a grain to two scruples, in an ounce of distilled water. The formula for Mr. Guthrie's ointment has already been given.

ANTIDOTE.—The antidote for nitrate of silver is common salt (*chloride of sodium*). When this comes in contact with lunar caustic, nitrate of soda and chloride of silver is produced: the latter compound is, according to the experiments of Orfila[o], innocuous. The contents of the stomach should be removed, and the inflammatory symptoms combated by demulcents, blood-letting, and the usual antiphlogistic means.

When the local use of nitrate of silver causes excessive pain, relief may be gained by washing the parts with a solution of common salt. Pieces of caustic have been left in the vagina and urethra without unpleasant consequences resulting. Injections of a solution of common salt are the best means of preventing bad effects.

To diminish the slate-coloured tint of the skin arising from nitrate of silver, acids or the super-salts offer the most probable means of success. The external and internal use of dilute nitric acid, or the internal employment of bitartrate of potash, may be tried: the discoloration is said to have yielded to a steady course of the last-mentioned substance[p].

1. LIQUOR ARGENTI NITRATIS, L.; *Solutio Argenti Nitratis,* E. (Nitrate of Silver, ʒj. [grs. 40, *E.*]; Distilled Water, f℥j. [grs. 1600, *E.*] Dissolve the nitrate of silver in the water, and strain; then, the access of light being prevented, keep it in a well-closed vessel.)—This solution is employed as a test of chlorine, chlorides, or hydrochloric acid (see p. 226).

2. SOLUTIO ARGENTI AMMONIATI, E.; *Solution of Ammoniaco-Nitrate of Silver; Hume's Test for Arsenious Acid.* (Nitrate of Silver, grs. xliv.; Distilled Water, f℥j.; Aqua Ammoniæ, a sufficiency. Dissolve the salt in the water, and add the aqua ammoniæ gradually, and towards the end cautiously, till the precipitate at first thrown down is very nearly, but not entirely, redissolved.)—Employed as a very delicate test for arsenious acid (see p. 628).

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[n] *Essay on Morbid Sensibility of the Stomach and Bowels,* 2d ed. p. 90.

[o] *Toxicol. Gén.*

[p] *United States Dispensatory.*

α. Hair Dye.—A solution of nitrate of silver is one of the substances used to dye the hair (see pp. 218 and 691).

β. Indelible Marking Ink; Permanent Ink.—A solution of nitrate of silver, coloured by sap-green. and thickened by mucilage, is used as a permanent ink for linen. The cloth is to be moistened with a solution of carbonate of soda, and afterwards dried. The *Ink* is composed of Nitrate of Silver, ℈v.; Sap-green, ℈j.; Powdered Gum, ʒij.; Distilled Water, f℥j.—The *Preparing Liquid* consists of Carbonate of Soda, ℥j.; Powdered Gum, ʒiij.; Water, f℥ij. Sometimes a solution of Ammoniated Nitrate of Silver, coloured and thickened as above, is used for the ink. The advantage of it is that it does not require the use of the preparing liquid.

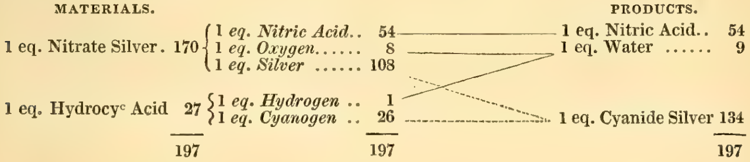
3. ARGEN'TI CYAN'IDUM, *L.*—CYANIDE OF SILVER.

History. — This compound, sometimes called *Hydrocyanate, Cyanuret*, or *Cyanodide of Silver*, or *Argentum Zootinicum*, has been studied by Scheele, Ittner, and Gay-Lussac.

Preparation.—In the London Pharmacopœia it is directed to be prepared as follows:—

Take of Nitrate of Silver, ℥ij. and ʒij.; Diluted Hydrocyanic Acid, Distilled Water, each Oj. Dissolve the Nitrate of Silver in the Water, and add to them the diluted Hydrocyanic Acid, and mix. Wash what is precipitated with distilled water, and dry it.

In this process one equivalent or 27 parts of hydrocyanic acid react on one equivalent or 170 parts of nitrate of silver; thereby generating one equivalent or 134 parts of cyanide of silver, and one equivalent or 9 parts of water, and setting free one equivalent or 54 parts of nitric acid.



Properties.—When first thrown down it is a curdy precipitate, which by drying becomes pulverulent. It is insipid, insoluble in water, but dissolves in caustic ammonia. It is decomposed by hydrochloric and hydrosulphuric acid, both of which develope with it hydrocyanic acid. It combines with other metallic cyanides to form the *argento-cyanides*. By exposure to the atmosphere and solar rays it assumes a violet tint. It is decomposed by mixture with neutral vegetable substances[q].

Characteristics.—It is insoluble in cold nitric acid, but soluble in the boiling acid. When carefully dried and then heated in a glass tube it yields cyanogen gas (which is readily known by its combustibility and the bluish-red colour of its flame) and a residuum of metallic silver. The latter is recognised by the before-mentioned tests for this metal.

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[q] *Journ. de Chim. Méd.* 2ⁿᵈᵉ Série, iii. 407.

Composition.—The following is the composition of this substance:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Silver	1	108	80·60
Cyanogen	1	26	19·40
Cyanide of Silver	1	134	100·00

Physiological Effects and Uses.—I am unacquainted with any experiments made to determine its effects on man and animals. Serre, of Montpellier[r], gave it in syphilitic maladies, in doses of one-tenth and even one-eighth of a grain, without the least inconvenience. It has been introduced into the London Pharmacopœia, at the suggestion of Mr. Everitt, as a source of hydrocyanic acid (*vide* p. 430).

OTHER COMPOUNDS OF SILVER.

1. ARGENTI OXYDUM; *Oxide of Silver.*—This compound is precipitated from a solution of nitrate of silver by lime water or liquor potassæ. Its colour is greyish brown. Its composition is 1 eq. silver 108, and 1 eq. oxygen 8 = 116. It was employed in medicine by Vans Mons and Sementini. More recently it has been used by Mr. Lane[rr]. Internally it has been exhibited, in doses of half a grain, in epileptic and gastralgic affections. In the form of ointment, composed of ten grains of oxide to a drachm of lard, it has been applied to venereal sores, and to the urethral membrane, by means of a bougie, in gonorrhœa. It does not possess the powerful chemical action of the nitrate of silver on the animal tissues.

2. ARGENTI CHLORIDUM; *Chloride of Silver.*—It is thrown down, in the form of a white curdy precipitate, from a solution of nitrate of silver by hydrochloric acid. Several of its properties have been already described (see p. 226). It is composed of 1 eq. of Silver 108 and 1 eq. Chloride 36 = 144. This, like the last-mentioned preparation of silver, was formerly used in medicine, but fell into disuse. More recently its medicinal employment has been recommended, by Dr. Perry[s], an American physician, in epilepsy, chronic dysentery, and chronic diarrhœa.—Dose, three grains four or five times daily. Thirty grains at one dose caused vomiting. Twelve grains administered daily for three months produced no unpleasant symptoms.

ORDER XXI.—MERCURY AND ITS COMPOUNDS.

1. HYDRARGYRUM, *L. E. D.*—MERCURY OR QUICKSILVER.

History.—No mention is made of quicksilver in the Old Testament; nor does Herodotus allude to it. From this we might infer that both the ancient Hebrews and Egyptians were unacquainted with it. But we are told on the authority of an Oriental writer, that the Egyptian magicians, in their attempts to imitate the miracles of Moses, employed wands and cords containing mercury, which, under the influence of the solar heat, imitated the motion of serpents[ss].

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[r] *Medico-Chirurgical Review, July* 1840.

[rr] *British and Foreign Medical Review.* Oct. 1841.

[s] *Ibid.* 2nde Série, iii. 408.

[ss] D'Herbelot, *Bibliothèque Orient.* art. *Moussa.*

Both Aristotle and Theophrastus[t] mention Ἄργυρος χυτὸς (*Argentum liquidum*): and the first of these naturalists says that Dædalus (who is supposed to have lived about 1300 years before Christ) communicated a power of motion to a wooden Venus by pouring quicksilver into it. We are also told that Dædalus was taught this art by the priests of Memphis. Pliny[u] and Dioscorides[v] also speak of mercury, and the latter writer describes the method of obtaining it from cinnabar.

Mercury was first employed medicinally by the Arabian physicians Avicenna and Rhazes; but they only ventured to use it externally against vermin and cutaneous diseases. We are indebted to that renowned empiric Paracelsus for its administration internally.

SYNONYMES.—The names by which this metal has been distinguished are numerous. Some have reference to its silvery appearance and liquid form: as Ὑδράργυρος, *Hydrargyrus* and *Hydrargyrum*, (from Ὕδωρ, *Aqua*, and Ἄργυρος, *Silver*); others to its mobility and liquidity, as well as its similarity to silver, such as *Argentum vivum*, *Aqua argentea*, *Aqua metallorum*, and *Quicksilver*. It has been called *Mercury*, after the messenger of the gods, on account of its volatility.

NATURAL HISTORY.—Mercury is comparatively a rare substance. It is found in the metallic state, either pure (*Native* or *Virgin Mercury*), in the form of globules, in the cavities of the other ores of this metal, or combined with silver (*Native Amalgam*). Bisulphuret of mercury (*Native Cinnabar*) is the most important of the quicksilver ores, since the metal of commerce is chiefly obtained from it. The principal mines of it are those of Idria in Carniola, and Almaden in Spain. The latter yielded 10,000 lbs. of cinnabar annually to Rome in the time of Pliny[w]. Protochloride of mercury (*Mercurial Horn Ore* or *Corneous Mercury*) is another of the ores of mercury. Traces of this metal have also been met with in common salt, during its distillation with sulphuric acid, by Rouelle, Proust, Westrumb, and Wurzur[x].

PREPARATION.—The extraction of quicksilver is very simple. In some places (as in the Palatinate and the duchy of Deux-Ponts) the native cinnabar is mixed with caustic lime, and distilled in iron retorts. In this process the lime abstracts the sulphur (forming *sulphuret of calcium*), and the disengaged mercury distils over. At Almaden the ore is roasted, by which the sulphur is converted into sulphurous acid, and the mercury volatilized. At Idria a modification of this process is followed[y].

COMMERCE.—Quicksilver is imported in cylindrical, wrought-iron bottles (holding from 60lbs. to 1cwt.), the mouth of each being closed by an iron screw; and also in goat-skins, two or three times doubled. The quantities imported in the years 1827, 1830, and 1840, and the places from which the metal was brought in the two first years, are thus stated in the Parliamentary Papers[z]:—

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[t] *De Lapidibus.*
[u] *Hist. Nat.* lib. xxxiii.
[v] Lib. v. cap. cx.
[w] *Hist. Nat.* xxxiii.
[x] Gmelin, *Handb. d. Chemie*, i. 1282.
[y] Dumas, *Traité de Chimie*, iv. 305.

	1827.	1830.	1840.
Spain and the Balearic Islands......	653,374 lbs.......	1,675,652 lbs.	328,556 lbs.
Gibraltar	121,320 ,, ...	— ,,	
Italy and the Italian Islands	108,567 ,, ...	331,416 ,,	
	883,261 ,, ...	2,007,068 ,,	

Properties.—At ordinary temperatures quicksilver is an odourless, tasteless, liquid metal, having a whitish colour, like silver or tin. Its sp. gr. is 13·5 or 13·6. When intimately mixed with pulverulent or fatty bodies, it loses its liquid character, and it is then said to be *killed*, *extinguished*, or *mortified*. When cooled down to — 38·66° F. it freezes, and crystallizes in needles and regular octohedrons. In this state it is ductile, malleable, and tenacious. At 662° F. it boils, and produces an invisible elastic vapour, whose sp. gr. is 6·976. Mr. Faraday[a] has shown that at common temperatures, and even when the air is present, mercury is always surrounded by a mercurial atmosphere; and, according to Stromeyer, at from 140° F. to 160° F., mercury, when mixed with water, is volatilized in considerable quantities. Chemists are not agreed as to the equivalent, or atomic weight, of this metal. Thus Dr. Thomson assumes 100; Gmelin, 101; Berzelius and Graham, 101·43; Brande, 200; Turner and Phillips, 202. I shall adopt the latter.

Characteristics.—In its *metallic* or *reguline* state, mercury is distinguished by its liquidity at common temperatures, and by its volatility. When invisible to the naked eye, and in a finely divided state, it may be readily detected by the white stain (called by workmen *quickening*) communicated to gold and silver. Mercurial vapour may be detected by exposing gold or silver to its influence. If mercury be in combination with other metals, and the tests now mentioned be not applicable, we may dissolve the suspected substance in nitric acid, and proceed as for the mercurial salts. The *mercurial compounds*, when heated with potash or soda, or their carbonates, yield globules of metallic mercury, which may be recognised by the properties already described. Solutions of the mercurial salts, placed for some time in contact with a piece of bright copper, and afterwards rubbed off with paper, leave a silvery stain behind, which disappears when the copper is heated to redness. Those compounds which are of themselves insoluble in water may be dissolved by digesting them with nitric acid; and the copper test may then be applied. In this way the mercury contained in calomel, vermilion, sulphate and iodide of mercury, may be readily recognised. Sulphuretted hydrogen produces, with mercurial solutions, a black precipitate (*sulphuret of mercury*).

Solutions of the *protosalts of mercury* yield, with caustic potash or soda, a grey or black precipitate (*oxide of mercury*); and, with iodide of potassium, a greenish or yellow precipitate (*iodide of mercury*).

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[z] *Statement of the Imports and Exports* for 1827 and 1830; and *Trade List* for 1840.

[a] *Quarterly Journal of Science*, x. 354.

Solutions of the *persalts of mercury* yield, with caustic potash or soda, a yellow or reddish precipitate (*binoxide of mercury*); and with iodide of potassium, a scarlet one (*biniodide of mercury*).

PURITY.—The purity of this metal is ascertained by its brilliancy and great mobility. Mechanical impurities—such as adhering dirt or dust—are instantly detected, and may be separated by straining through flannel, or by filtering through a small hole in the apex of an inverted cone of paper. The presence of lead, tin, zinc, or bismuth, may be suspected by the rapidity with which the metal tarnishes in the air, and by its small parts *tailing*, instead of preserving a spherical form. These impurities may be got rid of by distillation in an earthen retort.

Totally dissipated in vapour by heat. Dissolved by diluted nitric acid. When boiled in hydrochloric acid, the acid, when cold, is not coloured, nor is any thing precipitated from it by hydrosulphuric acid. Its specific gravity is 13·5. *Ph. Lond.*

"Entirely sublimed by heat: a globule moved along a sheet of paper leaves no trail: pure sulphuric acid agitated with it evaporates when heated, without leaving any residuum." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. 1. **Of Metallic Mercury.** *α. On Vegetables.*—Mercurial vapours are fatal to plants[b].

β. On Animals.—From the experiments of Moulin[c], Haighton[d], Viborg[e], and Gaspard[f], it appears that when *injected into the veins*, mercury collects in the small vessels of the neighbouring organs, and acts as a mechanical irritant. Thus, if thrown into the jugular vein, peripneumonia is excited; and, on examination after death, little abscesses and tubercles have been found in the lungs, in each of which was a globule of quicksilver as the nucleus.

γ. On Man.—Some difference of opinion exists as to the *effects of liquid mercury when swallowed;* one party asserting that it is poisonous, another that it is innocuous. The truth I believe to be this: so long as it retains the metallic state it is inert; but it sometimes combines with oxygen in the alimentary canal, and in this way acquires activity. Avicenna, Fallopius, and Brasavola, declared it harmless; Sue[ff] states that a patient took for a long time two pounds daily without injury; and I could refer to the experience of many others who have seen it employed in obstructions of the bowels, without proving noxious; but the fact is so generally known and admitted, as to require no further notice. In some instances, however, it has acted powerfully, more especially where it has been retained in the bowels for a considerable time; no doubt from becoming oxidized. Thus[g], Zwinger states that four ounces brought on profuse salivation four days after swallowing it. Laborde[gg] also tells us, that a man who retained seven ounces in his body for fourteen days, was attacked with profuse salivation, ulceration of the mouth, and paralysis of the extremities; and other cases of a similar kind might be quoted.

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[b] De Candolle, *Phys. Vég.* 1332.

[c] *Philosophical Transactions* for 1691, No. 192.

[d] Beddoes, *On Pulmonary Consumption.* 1799.

[e] Quoted by Wibmer, *Wirkung d. Arzneim.* iii. 88.

[f] Magendie, *Journ. de Physiol.* i.

[ff] *Mem. de la Facult. Med. d'Emulat.* 4th year, p. 252.

[g] *Miscell. Curiosa Decur.* 2^{nda}. Ann. 6, 1688.

[gg] *Journ. de Méd.* i. 3.

Dr. Christison considers the question set at rest by the Berlin College of Physicians, and that the metal is innocuous.

Applied externally, liquid mercury has sometimes produced bad effects. Dr. Scheel has related a fatal case, attended with salivation, brought on from wearing at the breast during six years a leathern bag, containing a few drachms of liquid mercury, as a prophylactic for itch and vermin[h].

The injurious effects of *mercurial vapours*, when inhaled or otherwise applied to the body, have been long known. They are observed in water-gilders, looking-glass silverers, barometer-makers, workmen employed in quicksilver mines, and in others exposed to mercurial emanations. In most instances an affection of the nervous system is brought on, and which is indicated by the *shaking palsy* or *tremblement mercuriel* (*tremor mercurialis*), which is sometimes attended with stammering (*psellismus metallicus*), vertigo, loss of memory, and other cerebral disorders, which frequently terminate fatally. The first symptom of shaking palsy is unsteadiness of the arm, succeeded by a kind of quivering of the muscles, which increases until the movements become of a convulsive character. In all the cases (about five or six in number) which have fallen under my notice, the shaking ceased during sleep. I have not seen the least benefit obtained by remedial means, although various modes of treatment were tried. This is not in accordance with the experience of Dr. Christison, who says the tremors "are cured easily though slowly." If the individual continue his business, other more dangerous symptoms come on, such as delirium or epilepsy, or apoplexy (*apoplexia mercurialis*); and ultimately death takes place.

In some instances salivation, ulceration of the mouth, and hæmoptysis, are produced by the vapour of mercury. The following remarkable case is an instance in point. In 1810, the Triumph man-of-war, and Phipps schooner, received on board several tons of quicksilver, saved from the wreck of a vessel near Cadiz. In consequence of the rotting of the bags the mercury escaped, and the whole of the crews became more or less affected. In the space of three weeks 200 men were salivated, two died, and all the animals, cats, dogs, sheep, fowls, a canary bird,—nay, even the rats, mice, and cockroaches, were destroyed[i].

As metallic mercury in the liquid state is not active, it has been thought that mercurial vapour must also be inactive. Thus, Dr. Christison thinks that the activity of the emanations arises from the oxidation of the metal before it is inhaled. I believe, however, with Buchner[j], Orfila[k], and others, that metallic mercury, in the finely divided state in which it must exist as vapour, is itself poisonous.

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[h] Richter, *Ausführ. Arzneim.* Supplem. Bd. 615.
[i] *Ed. Med. and Surg. Journ.* xxvi. 29.
[j] *Toxicologie.*
[k] *Toxicol. Gén.*

2. Of Mercurial Compounds.—Probably all the mercurial compounds are more or less noxious. The only doubtful exception to this statement is in the case of the sulphurets of this metal, which, according to Orfila[l], are inert.

a. Local effects.—For the most part, the local action of the mercurial compounds may be regarded as alterative, and more or less irritant. Many of the preparations (as the bichloride, the nitrates, &c.) are energetic caustics. The protoxide and protochloride (calomel) are very slightly irritant only: indeed, Mr. Annesley[m] asserts, from his experiments on dogs, and his experience with it in the human subject, that the latter substance is the reverse of an irritant; in other words, that when applied to the gastro-intestinal membrane it diminishes its vascularity. But I suspect some error of observation here.

β. Remote effects.—In *small* and *repeated doses*, the first obvious effect of mercurials is an increased activity in the secreting and exhaling apparatus. This is particularly observed in the digestive organs; the quantity of intestinal mucus, of bile, of saliva, of mucus of the mouth, and probably of pancreatic liquid, being augmented. The alvine discharges become more liquid, and contain a larger proportion of bile. The operation of the medicine does not stop here: the pulmonary, urino-genital, and conjunctival membranes, become moister, the urine is increased in quantity, the catamenial discharge is sometimes brought on, the skin becomes damper, and at the same time warmer; so that mercury seems to promote the excretions generally. The absorbent or lymphatic system seems also to be stimulated to increased activity; for we frequently observe that accumulations of fluids in the shut sacs (as the pleura, the peritoneum, the arachnoid, and synovial membranes) diminish in quantity, and in some cases rapidly disappear, under the use of mercury. At the same time, also, glandular swellings, enlargements, and indurations of various kinds, are dispersed. (For some other observations respecting the *liquefacient* action of mercury see p. 195.)

When our object is to obtain the *sialogogue* operation of mercurials, we give them in *somewhat larger doses.* To a certain extent the effects are the same as those already mentioned, but more intense. Of all the secretions, none are so uniformly and remarkably augmented as those of the mucous follicles of the mouth and the salivary glands; and the increased secretion is accompanied with more or less tenderness and inflammation of these parts, the whole constituting what is termed *salivation* or *ptyalism* (*salivatio*, *ptyalismus*, *sialismus*). The first symptoms of this affection are slight tenderness and tumefaction of the gums, which acquire a pale rose colour, except at the edges surrounding the teeth, where they are deep red. Gradually the mouth becomes exceedingly sore, and the tongue much swollen; a coppery taste is perceived, and the breath acquires a remarkable fetidity. The salivary glands soon become tender and swollen; the saliva and mucus of the mouth flow abundantly, sometimes to the extent of several pints in the twenty-four hours. During this state, the fat is rapidly absorbed, and the patient becomes exceedingly emaciated. The blood when drawn from a vein puts on the same appearance as it does in inflammatory diseases.

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[l] *Arch. Gén. de Méd.* xix. 330.
[m] *Diseases of India.*

The quantity of saliva and buccal mucus discharged by patients under the influence of mercury, varies according to the quantity of the medicine employed, the susceptibility of the patient, &c. Formerly salivation was carried to a much greater extent than it is at the present day. Thus Boerhaave[n] considered that a patient should spit three or four pounds in twenty-four hours; and Turner[o] says from two to three quarts are "a good and sufficient discharge." Modern experience has shown that all the good effects of mercurials may be gained by a very slight affection of the mouth. Several analyses have been made of saliva from patients under the influence of mercury. Fourcroy, Thomson, Bostock, and Devergie, failed to detect the least trace of mercury in it. But some other persons have been more successful, as will be hereafter mentioned. The following are the constituents of saliva during mercurial ptyalism, according to Dr. Thomson[p]:—

Coagulated Albumen	0·257
Mucus, with a little Albumen	0·367
Chloride of Sodium	0·090
Water	99·286
	100·000

It was an opal fluid, having a sp. gr. of 1·0038, and, by standing, deposited flakes of coagulated albumen. The nitrates of lead and mercury produced copious precipitates with it; but the ferrocyanide of potassium and the infusion of galls had no effect on it. Dr. Bostock[q] found the saliva discharged under the influence of mercury to differ from that of the healthy state, in being less viscid, and in containing a substance analogous to coagulated albumen[r], such as it exists in the serum of the blood; so that it would seem the mercurial action alters the secretion of the salivary glands, and makes it more analogous to the exhaled fluids of the serous membranes.

I have tested the urine of several patients in a profuse state of salivation without having detected a trace of albumen in it.

The effects of mercury hitherto described are such as are frequently produced for the cure of diseases: but occasionally other phenomena present themselves in individuals who have been subjected to the influence of this metal, and which have been considered as constituting a peculiar malady, to which the name of *mercurial disease* (*morbus mercurialis*, *hydrargyriasis* seu *hydrargyrosis*, *cachexia mercurialis*, &c.) has been given. The *pseudo-syphilis* or *cachexia syphiloidea* of some writers, is supposed to be syphilis, more or less modified by the mercurial disease[s]. The following are the ill effects which have been ascribed to this metal, and which Dieterich[t] regards as so many forms of the mercurial disease:—

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[n] *Aphorismi.*

[o] *Practical Dissertation on the Venereal Disease.* 1737.

[p] *Annal. of Phil.* vi. 397.

[q] *Medico-Chirurg. Trans.* xiii. 73.

[r] For some interesting observations on the conversion of albumen into mucus by the action of alkalis and various salts, see Brande, in the *Phil. Trans.* for 1809; Pearson in ditto, for 1810; Dr. B. G. Babington, in *Guy's Hospital Reports*, vol. 2; and Dr. G. Bird, in ditto, vol. 3.

[s] See some extraordinary cases of the combined effects of syphilis and mercury in the *Lancet* for 1832-3, vol. ii. p. 357.

1. Mercurial fever (*Febris mercurialis*, Dieter.)—Under this name Dieterich has included two febrile states. One of these (*Febris erethica; f. salivosa*) comes on a few days after the use of large doses of mercury, and is characterized by great restlessness, dryness of the mouth, headache, loss of appetite, nausea, hot and dry skin, quick pulse, red gums, swollen tongue, &c.: it usually terminates in a critical discharge (as profuse salivation, purging, or sweating), or an eruption makes its appearance. The affection which Mr. Pearson[u] denominated *mercurial erethism (erethismus mercurialis)*, is regarded by Dieterich as an adynamic mercurial fever *(febris adynamica)*. It is characterized by great depression of strength, a sense of anxiety about the præcordia, frequent sighing, trembling, partial or universal, a small quick pulse, sometimes vomiting, a pale contracted countenance, a sense of coldness; but the tongue is seldom furred, nor are the vital or natural functions much disordered. When these symptoms are present, a sudden and violent exertion of the animal power will occasionally prove fatal.

2. Excessive salivation (*Ptyalismus stomachalis mercurialis*, Dieter. *Stomatitis*).—I have already noticed mercurial salivation as far as it is ever purposely induced for the cure of diseases. But it sometimes happens, either from the inordinate employment of mercury, or from some peculiarity in the constitution of the patient, that the mouth becomes violently affected: the gums are tumefied and ulcerated; the tongue is swollen to such an extent, that it hangs out of the mouth, incapacitating the patient from either eating or speaking; the salivary glands are enlarged, most painful, and inflamed (*parotitis mercurialis*), and the saliva flows most copiously from the mouth. In one instance sixteen pounds are said to have been evacuated in twenty-four hours. In some cases the gums slough, the teeth loosen and drop out, and occasionally necrosis of the alveolar process takes place. During this time the system becomes extremely debilitated and emaciated; and, if no intermission be given to the use of mercury, involuntary actions of the muscular system come on, and the patient ultimately dies of exhaustion. I have repeatedly seen inflammation and ulceration of the mouth, and profuse salivation, induced by a few grains of calomel or some other mercurial.

A very frequent consequence of excessive mercurial salivation, and the attendant ulceration and sloughing, is contraction of the mucous membrane in the neighbourhood of the anterior arches of the palate, whereby the patient is prevented from opening the mouth, except to a very slight extent. I have met with several such cases. In one (that of a female) it followed the use of a few grains of blue pill, administered for a liver complaint. The patient remains unable to open her mouth wider than half an inch. Several operations have been performed by different surgeons, and the contracted parts freely divided, but the relief was only temporary. In another instance (that of a child, four years of age) it was produced by a few grains of calomel. Though several years have elapsed since, the patient is obliged to suck his food through the spaces left between the jaws by the loss of the alveolar process.

Non-mercurial salivation.—Salivation is occasionally induced by other medicinal agents, as iodine (see p. 237), iodide of potassium, nitric acid (see p. 291), hydrocyanic acid (see p. 437), arsenious acid (see p. 638), emetic tartar, the preparations of gold (see p. 683), and of copper, foxglove, even opium, and castor oil. Moreover, salivation sometimes arises spontaneously. Of this I have seen more than a dozen cases, mostly females. The greater number of them had not (according to their own account) taken medicine of any kind for several months. Several other cases of it are referred to by Dr. Christison[v] and by Dr. Watson[w]. Occasionally the cause of it is obvious: thus pregnancy, decayed teeth, sore throat, decomposing wool in the ears, &c.; but in many instances it cannot be detected.

It is sometimes a matter of considerable importance to distinguish the mercurial from the non-mercurial ptyalism. The essential symptoms of salivation from mercury are tumefaction, tenderness, and inflammation of the salivary glands; sponginess, swelling, and inflammation of the gums; copious secretion and excretion of saliva; remarkable fetor of the breath (usually termed mercurial fetor); brassy or coppery taste, and tongue generally swollen. These symptoms may be followed by ulceration and sloughing. But all the same phenomena may exist when no mercury has been taken. Even the so-called mercurial fetor of the breath is not a peculiar effect of this metal.

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[t] *Die Merkurialkrankheit.* Leipzig, 1837.

[u] *Observations on the Effects of various Articles of the Materia Medica*, p. 131. Lond. 1800.

[v] *Treatise on Poisons*, 3d ed. p. 380.

[w] *Lond. Med. Gaz.* Aug. 6, 1841.

But the disease which is most likely to be mistaken for the effects of mercury, is gangrene of the mouth, commonly called *Cancrum Oris*[x]. This usually, but not invariably, occurs in children. It consists of ulceration, followed by gangrene, of the inside of the cheek or lips, and is attended with a copious secretion of offensive saliva. Mercurial ptyalism may sometimes be distinguished from cancrum oris by the peculiar odour of the breath and the salivation preceding the ulceration and sloughing; and by the gums, salivary glands, and tongue, being tumefied and inflamed. But these symptoms are by no means to be relied on, as they may also attend cancrum oris; and it must be admitted, therefore, that the two affections closely resemble each other[y]. The following is a remarkable case of gangrene of the mouth occurring in the adult, and simulating the effects of mercury:—

A man affected with rheumatism, sent to a surgeon for advice, who, without seeing him, prescribed some pills, one of which was to be taken thrice daily. At the end of the week, his rheumatism not being relieved, he sent his wife again to the surgeon, who ordered the pills to be repeated. Another week elapsed, when the patient requested Mr. W. H. Coward, surgeon, of the New North Road, Hoxton, to see him, to whom I am indebted for part of the particulars of this case. Mr. Coward found his patient with the following symptoms: fever, great prostration of strength, sore throat, rheumatic pains in the wrists, profuse ptyalism, more than a pint of saliva being discharged per hour, with the breath having the "mercurial" odour; and on the inner surface of the right cheek a foul ulcer. He ascribed his present condition to the pills, as he had no sore mouth until after taking them. On cutting one of the pills, it was observed to have a light-brown colour, and the odour of opium: hence it was supposed they were composed of calomel and opium. Purgatives, tonics, and gargles of the chloride of soda, were used without avail, and, after some days, Mr. Coward requested me to see the patient. I found him in the following condition: right side of the face swollen and slightly red, gums swollen, red, and ulcerated, breath horribly offensive, its odour not distinguishable from that called mercurial; on the inner side of the cheek, near the orifice of the parotid duct, there was a slough about the size of a sixpenny piece: salivation most profuse; in fact the saliva flowed in a continued stream from his mouth; over the body were observed a few petechiæ. Coupling this man's condition with what I may call the "moral" circumstances of the case, I concluded that these symptoms arose from the use of mercury. Notwithstanding the means employed, the man became worse, the sloughing gradually increased until the whole of the right cheek became involved, and in about a week from my first visiting him he died.

A day or two before his death, I called upon the surgeon who had prescribed the pills, to tell him of the dangerous condition of the patient, arising, as I then thought, from the use of mercury. He assured me that the pills contained the Dover's powder only, and not an atom of any mercurial preparation. These pills he kept ready prepared, as he was in the habit of prescribing them frequently. To prove the correctness of his statement, he called his assistant, who made and dispensed the pills, and shewed me his day-book, in which was contained this patient's prescription. Furthermore, on comparing the pills which were already prepared with those taken by the patient, they were found to be identical.

3. Mercurial purging (*Diarrhœa mercurialis*).—Violent purging is a very frequent consequence of the use of mercury. It is frequently attended with

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[x] See an excellent account of this disease, by Dr. H. Green, in Costello's *Cyclopædia of Practical Surgery*, vol. i.

[y] In the *London Medical Gazette*, Aug. 28, 1840, is the report of an inquest held on the body of a child who died of cancrum oris, but whose death was alleged to have been caused by mercury.

griping, and sometimes with sanguineous evacuations. In some cases there is fulness of the left hypochondrium, burning pain and tenderness of the region of the pancreas, and the evacuations are frothy, whitish, tough, and often greenish, at least in the commencement, from the intermixed bile. These symptoms may fairly be referred to an affection of the pancreas, analogous to that of the salivary glands. Dieterich[z] terms it *ptyalismus pancreaticus mercurialis* (*diarrhœa salivalis, sialorrhœa alvina, ptyalismus abdominalis*).

4. Urorrhœa mercurialis.—Excessive secretion of urine, from the use of mercury, is very rare. Two cases are recorded by Schlichting[a].

5. Hidrosis mercurialis.—Profuse sweating is another occasional effect of mercury.

6. Skin diseases.—Several forms of skin diseases, both acute and chronic, have been regarded as part of the ill effects of mercury.

α. *Eczema mercuriale*, Pearson; (*Erythema mercuriale*, Spens and Mullins; *Lepra mercurialis*, Stokes and Moriarty; *Hydrargyria*, Alley, Rayer; *Erysipelas mercuriale*, Cullerier, Lagneau; *Spilosis mercurialis*, Schmalz).—This disease appears occasionally during the progress of a mercurial course. Some writers have frequently met with it:—thus, Alley[b] saw forty-three cases in ten years, and of this number eight terminated fatally. Rayer confesses, that in twenty years he never saw but three instances of it. I have seen only two cases of it. The disease consists of innumerable, minute, and pellucid vesicles, which have been mistaken for papulæ. These give the appearance of a diffused redness to the skin, and a sensation of roughness to the touch. Sometimes it is preceded and attended by febrile disorder. In two or three days the vesicles attain the size of a pin's head, and the included serum becomes opake and milky. It soon extends over the body, and is accompanied by tumefaction, tenderness, and itching. It usually terminates by desquamation: but in some cases a copious discharge takes place from the excoriated and tender surface; and when this ceases, the epidermis comes off in large flakes: in some instances the hair and nails fall off, and the eyes and eyebrows become entirely denuded. There is usually some affection of the respiratory organs, indicated by dry cough and tightness of the præcordia.

β. *Miliaria mercurialis.*—A miliary eruption has been observed by both Peter Frank and Dieterich, apparently as a consequence of the use of mercury.

γ. *Chronic skin diseases* (*Herpes*, *Psydracia*, and *Impetigo*).—These are doubtful consequences of the use of mercury. They have occurred after the employment of this metal; but considerable doubt exists, as to whether they ought to be regarded as the effect of the remedy, or of the disease for which they have been exhibited, or of some other condition of system. *Herpes præputialis* has been ascribed, by Mr. Pearson, to the previous use of mercury[c], and his opinion has been adopted by Dieterich[d]; but it certainly now and then occurs, when no mercury has been exhibited. The *Psydracia mercurialis* and *Impetigo mercurialis* of Dieterich are still more doubtful effects of mercury.

7. Inflammation or Congestion of the Eye, Fauces, and Periosteum, have been ascribed by some writers to the use of mercury; but by others the power of this agent to produce these diseases is denied. That they have followed the use of mercury cannot be doubted, but *post hoc* is not *ergo propter hoc.* Dieterich regards the maladies referred to as states of congestion, not of inflammation; and, therefore, calls them *Symphoreses* (from συμφόρησις, *an accumulation*).

The inflammation of the conjunctiva (*conjunctivitis mercurialis*; *symphoresis conjunctivæ oculi mercurialis*, Dieterich), ascribed by Von Ammon[e] to the use of mercury, should probably be referred to some other cause. He says it is characterized by a lilac tint around the cornea; that it sometimes precedes salivation, disappearing when this is established, and is commonly regarded as a catarrhal symptom.

The mercurial iritis (*iritis mercurialis*; *symphoresis ireos mercurialis*, Dieter.;

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[z] *Op. cit.*

[a] *Ephemerid*, A. C. L., Nuremburgæ, 1748, tom. viii. Obs. viii. p. 25, quoted by Dieterich, *op. cit.*

[b] *Observ. on the Hydrargyria*, 1810.

[c] Bateman, *Pract. Synopsis of Cutaneous Diseases*, 6th ed.

[d] *Op. cit.*

[e] *Rust's Magazin*, 1830.

iritis rheumatico-mercurialis, Jaeger), described by Mr. Travers[f], was, in all probability, an iritis arising from some other cause than mercury[g].

The so-called mercurial retinitis (*symphoresis retinæ oculi mercurialis*, Dieter.) may be explained in the same way.

An inflammation of the fauces sometimes occurs after the use of mercury (*angina mercurialis ; symphoresis faucium mercurialis*, Dieter.) It may come on in five or six days after the use of mercury, and assume an acute form, with a tendency to slough[h]; or it may appear after the employment of mercury for five or six weeks, and take on a chronic form[i].

Inflammation of the bone or periosteum, and the consequent production of nodes (*symphoresis periostei mercurialis*, Dieter.), has been ascribed to mercury. But the disease is rarely or never seen after the use of this mineral, except when it has been given for the cure of a venereal affection, to which, in fact, it ought with more propriety to be referred[j].

8. Hypertrophies (*Hypertrophiæ*, Dieter.)—Enlargement of the inguinal, axillary, and mesenteric glands (*adenophyma inguinale mercuriale ; ad. axillare merc.*; *ad. meseraicum merc.* Dieter.), as well as of some of the secreting glands, viz. the parotid glands, the pancreas, the testicles, and liver (*adenophyma parotideum merc. ; ad. pancreaticum merc. ; ad. testiculi merc.; hepatophyma merc.*), and condyloma and ganglion (*condyloma et ganglion mercuriale*, Dieter.) have been ascribed by some[k] to the use of mercury, but, as I believe, on insufficient grounds.

9. Ulceration and Sloughing.—Ulceration of the mouth is a well-known effect of mercury. Ulceration of the throat is likewise a consequence of the use of this mineral (*mercurial ulcerated throat*, Mathias ; *mercurial sore throat*, Bacot[l]). Sloughing of the same parts may also be induced. It is well known that venereal sores (especially those called phagedenic) at times assume a sloughing disposition, in consequence of the improper use of mercury[ll]. Ulceration of the fibrous membranes (*ulcus membranæ fibrosæ mercuriale*) and absorbent glands (*ulcus glandulorum mercuriale*) has been ascribed to the use of mercury[m].

10. Neuroses mercuriales.—Various symptoms, indicating a disordered condition of the nervous system, are met with in persons who have been exposed to the baneful influence of mercury : such as wandering pains (*neuralgia mercurialis*); a tremulous condition of the muscular system (*tremor mercurialis*), sometimes accompanied with stammering (*psellismus metallicus*), and occasionally terminating in paralysis (*paralysis mercurialis*), epilepsy or apoplexy (*apoplexia mercurialis*). To these Dieterich[n] adds asthma (*asthma mercurialis*), of which he only saw one case, amaurosis (*amaurosis mercurialis*), and hypochondriasis (*hypochondriasis mercurialis*).

Of these, the best known is the shaking palsy (*tremor mercurialis: tremblement mercuriel*), a remarkable affection which occurs among workmen exposed to the action of the vapour of mercury, such as miners, gilders, barometer-makers, looking-glass silverers, &c. The first symptom of it is unsteadiness of the arm, succeeded by a kind of quivering of the muscles, which increases until the movements become of a convulsive character. In all the cases which I have seen, the movements were suspended during sleep.

11. Cachexia (*Cachexia mercurialis*).—This condition is characterized by disorder of the digestive organs, loss of appetite, wasting, incapability of much exertion, with increased secretion from all the organs, especially from the salivary glands[nn].

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[f] *Surgical Essays*, i. 59.

[g] Mackenzie, *On Diseases of the Eye*, 2d ed. p. 496.

[h] Colles, *Pract. Observ. on the Vener. Disease*, p. 45.

[i] Dieterich, *op. cit.* 273.

[j] Mr. Lawrence, *Lect. on Surg.* in *Med. Gaz.* v. 805; Colles, *op. cit.* p. 189.

[k] Mathias, *op. cit.;* and Dieterich, *op. cit.*

[l] *Med. Gaz.* iii. 312.

[ll] Sir A. Cooper, *Lectures on Surgery*, in *Lancet*, iv. 42; Carmichael, *On Venereal Diseases*, p. 165, *et seq.* 2nd ed.

[m] Dieterich, *op. cit.* p. 376.

[n] *Op. cit.*

[nn] Mr. Travers (*Further Inquiry concerning Constitutional Irritation*, p. 87) says mercurial cachexia is characterized "by irritable circulation, extreme pallor and emaciation, an acute and rapid hectic, and an almost invariable termination in phthisis."

The foregoing are the most important of the ill effects ascribed to the use of mercury. As I have already stated, some of them ought probably to be referred to other causes, and not to the use of this mineral; but as doubt must necessarily be entertained on this point, I have thought it more advisable to mention them. The student will find some pertinent observatious concerning them, in a paper by Dr. Musgrave[o], and in Dr. Currie's pamphlet[p].

In excessive doses: acute poisoning.—When *large doses* of some of the soluble salts of mercury have been swallowed, *gastro-enteritis* is produced. The patient complains of an acrid styptic taste in the mouth, and a feeling of burning and tightness in the throat; the face is usually flushed and sometimes swelled, violent vomiting and purging (frequently of bloody matters) soon come on, the vomiting being increased by every thing taken into the stomach: oftentimes there is irritation of the urinary passages, and sometimes even suppression of the urine; the pulse is small, frequent, and contracted; the respiration difficult; the extremities cold. In some cases *salivation* is produced: this seldom comes on during the first 24 hours; and is seldom delayed beyond the fourth day. Towards the termination of the case, some indications of *disorder of the cerebro-spinal system* come on, such as slight drowsiness or stupor, or even coma; tremors and twitchings of the muscles, and sometimes even violent convulsions; in some cases paraplegia. These symptoms terminate in death. Post-mortem examination discovers inflammation (and its consequences) of the gastro-intestinal membrane.

THEORY OF THE ACTION OF MERCURY.—There are many disputed points connected with the action of mercurials, which it will be convenient to examine under this head.

1. *Absorption of mercury.*—By the external or internal use of mercury, this metal becomes absorbed (in what state has not been ascertained), and is subsequently either deposited in some of the solids of the body, or thrown out of the system by some of the excretories.

The accuracy of this statement is proved by the following facts:—

α. *Mercury has been detected in the blood* by Zeller, Buchner, Schubarth[q], Colson[r], and Dieterich[s]. It appears to be in such intimate combination with this vital fluid that it cannot be recognised by the ordinary tests. Destructive distillation is, in most cases, necessary for its detection.

β. *Mercury has been found in the secretions,* viz., in the perspiration, the saliva, the gastro-intestinal secretion, the bile, the urine, and the fluid of ulcers[t]. The blackening of the skin, mentioned both by Harrold[u] and Rigby[v], as having occurred in consequence of the use of mercury subsequent to the employment of sulphur, establishes the existence of mercury in the cutaneous transpiration. The sulphur and the mercury were thrown out of the system by the skin, and immediately they were out of the sphere of the vital powers, they entered into union and formed the black sulphuret of mercury, which was deposited on the integument in a pulverulent form.

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[o] *Edinb. Med. and Surg. Journ.* vol. xxviii.
[p] *Examination of the Prejudice commonly entertained against Mercury.*
[q] Quoted by Dr. Christison, *On Poisons*, 3rd ed. p. 366.
[r] *Arch. Gén.* xii. 68.
[s] *Op. cit.*
[t] Christison, Colson, and Dieterich, *op. cit.*
[u] *Meckel's Archiv*, iii. 532.
[v] *Lond. Med. Rep.* April 1837.

γ. *Mercury has been found in the reguline state in the organic solids*, viz., in the bones, brain, synovial capsules, the pleura, the humours of the eye, the cellular tissue, the lungs, &c.[w] In what part of the system reduction is effected, has not been made out.

2. *The constitutional effects of mercury are consequences of its absorption.* For, in the *first* place, mercurials affect the general system to whatever part of the body they be applied, whether to the mucous membranes, the cutaneous system, or the cellular tissue, or injected into the veins. *Secondly*, the action of mercurials on the system is assisted by the use of blood-letting and emetics;—agents which promote absorption. *Thirdly*, when mercurials are administered by the stomach, and excite purging, they rarely affect the general system, apparently in consequence of the function of absorption being suspended.

3. *After absorption, mercury effects changes in the qualities of the blood, and in the action of the whole organism, but especially the apparatus of organic life.*—Soon after salivation has been established, the blood exhibits an inflammatory crust. At a later period its colour deepens, and its coagulability is diminished: the proportion of clot, and therefore of fibrin, to serum becomes smaller. "The formation of albumen and mucus," says Dieterich[x], "sinks to that of serum; the whole organic formation of the patient is less consistent and cohesive." The same authority also tells us, that under the influence of mercury the electrical condition of the blood changes from the negative (healthy) state to that of positive. According to Dr. Farre[y], it diminishes the number of red globules of the blood. The evacuations from all the secreting and exhaling organs, especially from the mucous follicles and salivary glands, is much increased. The secretion of bile is also promoted. Dr. Wilson Philip[z] says, "mercury has a specific operation on the liver,—a power not merely of exciting its functions, but of correcting the various derangements of that function in a way which it does not possess with respect to any other organ, and which no other medicine possesses with respect to the liver." I confess I am not acquainted with any facts warranting this broad assertion. The purgative effects of mercury arise partly from the increased secretion of bile, and partly from the stimulus given to the mucous lining of the alimentary tube; more particularly to its follicular apparatus. The *nervous system* appears also to be specifically affected by mercurials. This is to be inferred partly from the effects produced in those who are subjected to the vapours of this metal, such as the shaking palsy, &c. and partly from the effects of the soluble salts, when given in enormous doses. The *heart* and *lungs* are, in some cases,

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[w] Christison, *op. cit.*; Wibmer, *Wirkung d. Arzneim.* iii. 85; Colson and Dieterich, *op. cit.*

[x] *Op. cit.* 80.

[y] Ferguson's *Essays on the Diseases of Women*, part i. p. 216.—"A full plethoric woman, of a purple red complexion, consulted me," says Dr. Farre, "for hæmorrhage from the stomach, depending on engorgement, without organic disease. I gave her mercury, and in six weeks blanched her as white as a lily."

[z] *On the Influence of Minute Doses of Mercury*, p. 14.

remarkably affected. This was particularly observed by Sir Benjamin Brodie[a] in his experiments on animals with corrosive sublimate; as also by Smith, Orfila, and Gaspard. The affection of the *urinary organs* in poisoning by corrosive sublimate is also not to be overlooked.

4. *The nature of the influence exercised by mercury over the organism* has been a fertile source of discussion. One class of writers has regarded it as mechanical, a second as chemical, a third as dynamical.

α. *Mechanical hypothesis.*—Astruc[b] and Barry[c] fancied that mercury acted by its weight, its divisibility, and its mobility; and thus getting into the blood, separated its globules, rendered it more fluid and fit for secretion, made the lymph thinner, and overcame any existing obstructions.

β. *Chemical hypotheses.*—Some have advocated the chemical operation of mercurials, and have endeavoured to explain their curative powers in the venereal disease by reference to their chemical properties, but without success. Thus Mitié, Pressavin[d], and Swediaur[e], assumed that mercury acted chemically on the syphilitic poison, as acids and alkalis do on each other; while Girtanner[f] supposed that the efficacy of mercurials depended on the oxygen they contain. To both hypotheses the same objection applies: if they were true, the larger the quantity of mercury used, the more effectually would the venereal disease be cured. Now this is not found to be the case. Dr. Cullen[g] endeavoured to account for the action of mercury on the salivary glands, in preference to other organs, by assuming that it has a particular disposition to unite with ammoniacal salts, with which it passes off by the various excretions; and as the saliva was supposed to contain more of these salts than other secretions, he thus accounted for the larger quantity of mercury which passed off by these glands, and which, being in this way applied to the excretories, occasioned salivation. But the whole hypothesis falls to the ground when it is known that mercury has no "particular disposition" to unite with the ammoniacal salts; and that, even if it had, other secretions are as abundantly supplied with these salts as the saliva. Dr. John Murray substituted another hypothesis, but equally objectionable:—mercury, says he, cannot pass off by the urine, because of the phosphoric acid contained in this fluid, and which would form, with the mercury, an insoluble compound. It must, therefore, be thrown out of the system by other secretions, particularly by the saliva, which facilitates this transmission by the affinity which the muriatic acid, the soda, and the ammonia of the secretion, have for the oxide of mercury, and by which a compound soluble in water is formed. The answer to this hypothesis is, that mercury *is* thrown out of the system by the urine, and probably in larger quantity than by the saliva; secondly, the saliva also contains phosphatic salts, according to Tiedemann and Gmelin.

γ. *Dynamical hypotheses.*—Some writers have principally directed their attention to the quality of the effects induced by mercury, and have termed this mineral stimulant, sedative, both stimulant and sedative, tonic or alterative. Those who assume mercury to be a *stimulant* or *excitant* are not agreed as to whether one or more parts or the whole system are stimulated, and if particular parts, what these are. Thus Hecker fixes on the lymphatic system, Schone on the arterial capillary system, Reil on the nerves[h]. The simple answer to all of them is, that other stimulants are not capable of producing the same effects on the constitution as mercury; nay, are frequently hurtful in the very cases in which this metal is beneficial.

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[a] *Phil. Trans.* for 1812.

[b] *De Morb. Ven.* ii. 149.

[c] *Medical Transactions*, i. 25.

[d] Quoted by Richter, *Ausführ. Arzneim.* iv. 305.

[e] *Practical Observations on Venereal Complaints.*

[f] *Abhandl. ü. d. Vener. Krankh.*

[g] *Treat. of the Mat. Med.* ii. 446.

[h] Richter, *op. cit.* v. 306.

On the other hand, Conradi, Bertele, and Horn[i], considered it to be a *weakening agent* or *sedative*. Hence those who adopt this hypothesis must assume that the diseases in which mercury is beneficial are of a phlogistic or hypersthenic character; and that syphilis, therefore, is of this kind,—an explanation not at all satisfactory, nor consistent with facts. Of late years the sedative operation of some of the mercurial preparations (calomel and mercurial ointment) has been assumed (particularly by our countrymen practising in the East), from the circumstance that these agents allay vomiting and diarrhœa in yellow fever, cholera, and other dangerous diseases. But even admitting that mercurials do produce these effects, this is hardly a sufficient ground for denominating them sedatives.

Some think that mercurials, in *small* or moderate doses, are *stimulants*, but in *excessive* doses, *sedatives*; and that this sedative operation is common to all substances when employed in large quantities. This is the opinion of Dr. Wilson Philip[j].

Dr. Murray[k] calls mercury a tonic; Vogt[l] terms it an alterative resolvent; Sundelin[m] places it among the resolvent alteratives, under the designation of liquefacient (*verflüssigende*). Mr. Hunter[n] accounts for its beneficial effects in syphilis, by saying it produces an irritation of a different kind to that caused by the venereal disease, and that it counteracts the latter by destroying the diseased action of the living parts.

USES. 1. **Of Metallic Mercury.**—Liquid mercury has been used as a *chemical* agent, to dissolve silver coins which may have been swallowed; and as a *mechanical* agent, to remove obstructions of the bowels: for example, intus-susception, or intestinal invagination. But neither theory nor experience seem favourable to its use; for in the greater number of cases the intus-susception is progressive—that is, the superior portion of the gut is insinuated into the lower portion, and, therefore, the pressure of the metal on the sides of the intestine cannot give relief; and even in cases of retrograde intus-susception,—that is, where the lower portion of the bowels passes into the upper, mercury, instead of pressing the intus-suscepted portion back, might push it farther on, by getting into the angle of reflection between the containing and inverted gut[o]. *Lastly*, water, which had been boiled with mercury (*aqua mercurialis cocta*), was at one time used as an anthelmintic; but if the metal be pure, the water takes up no appreciable quantity of it. Moreover, it would appear that mercury has no particular anthelmintic powers: for persons who were salivated have not been freed from their worms, and Scopoli very frequently found ascarides in the workers of the quicksilver mines of Idria[p].

ADMINISTRATION.—When taken internally, it has been administered in various doses, from an ounce to a pound or more.

2. **Of the Preparations of Mercury.**—As *errhines* or *emetics*, mercu-

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[i] Quoted by Richter, *op. cit.* v. 307.
[j] *Op. cit.*
[k] *Syst. of Mat. Med.*
[l] *Pharmakodynamik.*
[m] *Heilmittellehre.*
[n] *Treatise on the Venereal Disease.*
[o] Hunter, *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, i. 103.
[p] Bremser, *Sur les Vers Intest.* 428.

rials are never resorted to now, though formerly the *subsulphate* was used for these purposes.

As *alteratives*, they are given in small doses in various chronic diseases; such, for example, as dyspepsia, gout, chronic skin diseases, scrofula, &c. Calomel is said to be less beneficial as an alterative than blue pill, on account of its more irritating action on the bowels. The *hydragyrum cum cretâ* is an excellent alterative, especially for children.

Certain preparations of mercury (as blue pill, calomel, and the *hydrargyrum cum cretâ*) are employed as *purgatives*. They promote secretion from the mucous follicles of the intestines, from the liver, and the pancreas. They are rarely, however, used alone; being, in general, either combined with, or followed by, other cathartics (as jalap, senna, colocynth, or the saline purgatives). Thus it is a common practice to exhibit a blue pill or calomel at night, and an aperient draught the following morning, the object being to allow the pill to remain as long as possible in the bowels, in order that it may the more effectually act on the liver. Mercurial purgatives are administered for various purposes; sometimes as anthelmintics, sometimes to assist in evacuating the contents of the alimentary canal; but more commonly with the view of promoting the secretions, particularly of the liver, or of producing counter-irritation, and thereby of relieving affections of other organs, as the skin or head.

The great value of mercurials is experienced when they are given as *sialogogues*. Formerly it was supposed that the beneficial effects of mercury were proportionate to the degree of ptyalism, and thus to eradicate particular affections, it was thought necessary to cause the evacuation of a given quantity of saliva. "I have heard," says Dr. Wilson Philip[q], "the late Dr. Monro, of Edinburgh, state, the quantity of saliva which must be discharged daily to eradicate particular affections." Modern experience has proved the incorrectness of this notion; and we now rarely find it necessary to excite a high degree of salivation; indeed, frequently it would be prejudicial, but we sometimes find it requisite to keep up this effect for several weeks, particularly in diseases of a chronic character.

a. Production of sore mouth and salivation.—One of the most efficacious methods of putting the system under the influence of mercury is *friction* with the *unguentum hydrargyri;* but the troublesome and unpleasant nature of the process is a strong objection to it in practice, more especially in venereal diseases, in which patients usually desire secrecy. Full directions for its employment will be given hereafter (vide *Ung. Hydrargyri*). In the year 1779, Mr. Clare[r] proposed a new method of causing salivation by friction, and which consists in rubbing two or three grains of calomel, or of the protoxide of mercury, on the inner surface of the cheeks and gums. It is said that the metal quickly becomes absorbed, and causes salivation, and if care be taken not to swallow the saliva, diarrhœa does not occur. Notwithstanding that Hunter, Cruikshank, and others, have tried this plan, and reported favourably of it, and that it is free from the objections made to the use of mercurial ointment, it has never been a popular remedy. *Fumigation*, as a means of affecting the general system, is an old method of treating venereal diseases. Turner[s] employed for this purpose cinnabar; Lalouette[t] calomel; and the late Mr. Abernethy[u] the protoxide. Mr. Colles[v] has frequently seen fumigation fail in exciting salivation. He says, an easy mode of fumigating any part is by using *mercurial candles* (composed of cinnabar or oxide of mercury mixed with melted wax, with a wick, and burnt under a curved glass funnel.) Baumé used *mercurial pediluvia* to excite salivation, composed of half a grain of corrosive sublimate dissolved in a pint of distilled water, and in a solution of this strength the patient immersed his feet for the space of two hours; several objections, however, exist to the practice, which has been rarely followed. Upon the whole, the most convenient method of producing salivation is by the *internal use of mercurials*, particularly of those preparations which are mild in their local action, as blue pill, calomel, and the *hydrargyrum cum cretâ.*

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[q] *Op. cit.* p. 19.

[r] *Essay on the Cure of Abscesses by Caustic; also, a New method of introducing Mercury into the Circulation.* 1779.

β. Treatment before and during salivation.—Formerly the use of mercurials was preceded by antiphlogistic measures, such as blood-letting, purging, warm bathing, and low diet, but they are now rarely resorted to, though useful, by facilitating absorption. Mr. Colles[w] thinks that these preparatory measures have been improperly omitted, and that the want of them has, of late years, contributed to bring this valuable remedy into much disrepute—in which opinion I am disposed to join him. Occasionally great difficulty is experienced in affecting the mouth, a circumstance which may arise from the irritable condition of the bowels: and when this is the case, inunction should be resorted to, or opium or vegetable astringents conjoined. Sometimes, however, the system appears insusceptible to the influence of mercury, and this may arise from idiosyncrasy, or from the presence of some disease, particularly fever. Emetics and blood-letting are useful in these cases, as they promote absorption; and as the influence of the former depends on the state of nausea produced, tartar emetic will be the best vomit, since it is the most powerful nauseant. Varying the mode of administering the mercury will also sometimes facilitate its operation on the system: thus, if it have been employed internally, inunction should be tried, and *vice versâ.*

During the time that the patient's mouth is sore, he should, if possible, confine himself to the house, use warm clothing, avoid exposure to cold, take light but nourishing food, and regulate the state of his stomach and bowels. Mr. Hunter thought that during a mercurial course the manner of living need not be altered: but Mr. Colles[x] has properly, I think, objected to this. If the discharge become excessive, or ulceration of the gums take place, the further use of mercury is of course to be stopped; and, in order to moderate the effect already produced, the patient should be freely exposed to a cold but dry air, use purgatives and opium, and wash his mouth with some astringent and stimulating liquid. I have generally employed, as a gargle, a solution of the chloride of soda or of lime; but in the absence of these, a solution of alum, or of sulphate of copper, may be used. Dr. Watson[y] observes that "when the flow of saliva, and the soreness of the gums, form the chief part of the grievance, I have found nothing so generally useful as a gargle made of brandy and water; in the proportion of one part of brandy to four or five of water." With regard to internal remedies, I have no confidence in any as having a specific power of stopping salivation, though iodine, sulphur, nitre, and other substances, have been strongly recommended. Sometimes sulphate of quina is administered with advantage.

γ. Accidents during salivation.—Occasionally, during salivation, certain effects result from mercury, which are in no way necessary or useful in a therapeutical point of view: on the contrary, some of them are highly prejudicial. Thus, sometimes, *excessive salivation, with ulceration of the gums,* takes place, as already noticed: not unfrequently *gastro-intestinal irritation* (or actual inflammation) comes on, and which may require the suspension of the use of mercury, or its employment by way of inunction, or its combination with opium or vegetable astringents. I have already noticed *fever*, *eczema mercuriale*, *mercurial erethysm* of Pearson, &c. as other occasional effects. In feeble and irritable habits, mercury sometimes disposes sores to *slough*. Occasionally a kind of *metastasis* of the mercurial irritation is observed: thus, swallowing a large quantity of cold water, or exposing the body to cold and moisture, has caused a temporary cessation of salivation, attended with violent pains or convulsions, or great irritability of stomach.

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[s] *On the Venereal Disease.*

[t] *Nouvelle Méthode de traiter les Malad. Vénér.* 1776.

[u] *Surgical and Physiological Essays.*

[v] *Op. cit.* p. 58.

[w] *Practical Observations on the Venereal Disease,* p. 28.

[x] *Op. cit.* p. 34.

[y] *Lond. Med. Gaz.* Dec. 25, 1840.

δ. *Curative action of salivation.*—Though no surgeon ascribes the curative action of mercury to the salivation, yet, without this effect, the curative influence is not usually observed. Hence, though the one cannot be considered to stand to the other in the relation of cause and effect, yet the two are usually contemporaneous: so that when we fail to induce some affection of the mouth, we do not observe the beneficial effects of mercury[z].

Having offered these general remarks on salivation as a remedial agent, I proceed to notice its use in particular diseases[a].

α. *Fever.*—It has been said that salivation diminishes the susceptibility to the contagion of fever, whether common or specific; but that it is not an absolute preventive is shown by the fact, that patients under the full influence of mercury have caught fever and died of it, as will be found noticed by my friend, Dr. Clutterbuck, in his *Inquiry into the Seat and Nature of Fever.* I have several times used mercurials as sialogogues in fever; I believe, for the most part, with advantage. I have only used them when there was some marked local determination or inflammatory condition. I have seen several fatal cases of fever in which mercurials were used profusely, without having any effect on the mouth; but in other instances, in which the mouth became affected, recovery took place. My experience, therefore, agrees with that of Dr. Copland[b], namely, that death, after salivation has been established, is very rare. Whether the recovery was the consequence of the mercurial action, or the salivation the result of the mitigation of the disorder, as Dr. Bancroft[c] and Dr. Graves[d] assert, cannot be positively proved, though I think the first more probable. Dr. Graves[e] declares the use of mercury in fever to be both injudicious and unnecessary, unless inflammation of some organ be set up. In this opinion I cannot agree with him. Dr. Macartney[f], on the other hand, says, "In no single instance have I known it [mercury] fail in arresting the progress of the disease, provided the fever be not combined with visceral affections, or characterized from the beginning with unusual prostration of strength." The great indisposition of the system, in fever, to take on the mercurial action, is frequently a most annoying circumstance. It may sometimes be overcome by the employment of mercurials both internally and externally. Mr. Lempriere[g], who practised in Jamaica, finding that calomel was often exhibited in immense quantities, without exciting any apparent action, was induced to employ corrosive sublimate in doses of the eighth part of a grain, with the addition of ten drops of laudanum, and this quantity was repeated every hour until some affection of the mouth was observed, or until the more alarming symptoms had considerably abated.

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[z] On this subject consult Colles, *op. cit.* p. 31.

[a] The following are Dr. Farre's rules for the exhibition of mercury (Ferguson, *op. supra cit.* page 220):—

"1. Never to give mercury when there is an idiosyncrasy against it." The following case is illustrative of the danger of neglecting this advice:—

"A patient of Mr. G.'s, of the Borough, desired him never to give her any mercury, as that drug was a poison to her whole family, to which he, without arguing the point, at once assented. In Mr. G.'s absence, the late Mr. C. was consulted as to some trifling disorder of the bowels, and, not knowing the peculiarity of his patient's constitution, prescribed two grains of calomel. The next morning the lady shewed the prescription to Mr. C., saying that she was sure she had taken mercury, as she felt it in her mouth. In a few hours ptyalism ensued; in consequence of which she lost her teeth, her jaw exfoliated, and she ultimately, after a succession of ailments, died, in about two years."

"2. Mercury should be used in all active congestions—pyrexia, phlogosis, phlegmon, ophthalmia, strabismus, cynanche laryngea, cynanche trachealis, pneumonia, and in all inflammatory diseases. In the adhesive stages of dysentery, in the phlegmasiæ, where there is inflammation with power, in tetanus, hemiplegia, paraplegia, neuralgia, in their states of active congestion.

"3. Mercury is hurtful, or doubtful—in the malignant or asthenic forms of pyrexia, where there is low delirium; but in phrenitis, and in that peculiar form of it, the *coup de soleil,* it is most effectual. It is hurtful in tetanus from punctured wound, and in all cases of irritable disease.

"In idiopathic iritis, it is as effectual as bark in ague; but in the traumatic it is injurious, as it interferes with the closing of the vessels by adhesive inflammation: hence in all hæmorrhage, where the orifices of vessels require to be closed, it is hurtful.

"In the hemiplegia of lesion, in asthenic paraplegia, in the neuralgia of irritation, it is bad. Poor Pemberton was three times salivated for tic douloureux, and three times the worse for it.

"It is hurtful in the inveterate forms of scrofulous ophthalmia, though useful in the early stage. It is bad in the amaurosis of depletion.

"It is useful in puerperal peritonitis, and hurtful in the typhoid form of it; as also in the ulcerative stage of dysentery.

"In general, it is doubtful in the suppurative stages of inflammation, and in all erysipelatous and erythematous inflammations, or those tending to gangrene. It is hurtful in all cases of pure asthenia from deficiency of red blood."

[b] *Dict. of Pract. Med.* i. 929.

The beneficial influence of mercurials has been more particularly experienced in the fevers of warm climates, especially those of the East Indies[h]. It has been said by several writers[i], that in the yellow fever of the West Indies its beneficial effects are not equally evident.

β. *Inflammation.*—Of late years various forms of inflammation have been most successfully combated by the use of mercury. Hence this mineral is termed an *antiphlogistic.* We are principally indebted to Dr. Hamilton[j], Dr. Yeats[k], Dr. Wright[l], and Rambach[m], for its introduction into use in this form of disease. It is principally valuable in adhesive inflammation to stop, control, or prevent the effusion of coagulable lymph. On the other hand it may prove injurious in erythematous, scrofulous, malignant, and gangrenous inflammation, as well as in inflammation accompanied with debility or great irritability of the nervous system. Its curative power is not satisfactorily accounted for by the equalization of the circulation, the augmentation of the secretions, or the increased activity of the absorbents caused by mercury (see p. 196).

Mercury is not equally serviceable in all inflammations. The *nature of the tissue*, the *structure of the organ affected*, and the *quality* or *kind* of inflammation, are points of considerable importance as affecting its use.

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[c] *On Yellow Fever.*

[d] *Lond. Med. Gaz.* xx. 147.

[e] *Op. cit.*

[f] *Treatise on Inflammation*, p. 162.

[g] *Pract. Observ. on Diseases of the Army of Jamaica.*

[h] Johnson, *On Diseases of Tropical Climates*, pp. 32, 96, 97, 122, &c. &c. 3^{d} ed.; Annesley, *On the Diseases of India*, p. 391, 2^{d} ed.

[i] Johnson, *op. cit.* p. 37; Bancroft, *On Yellow Fever;* Musgrave, *Edinb. Med. and Surg. Journ.* xxviii. 40.

[j] Duncan's *Med. Comm.* vol. ix.

[k] Duncan's *Ann. of Med.* vol. vii.

[l] *Med. Facts and Observ.* vol. vii.

[m] *Dissert. Usus Mercurii in Morb. Inflamm.* 1794.

Thus it appears that inflammations of *membranous tissues* are those principally benefited by a mercurial plan of treatment; and more especially those in which there is a tendency to the exudation of coagulable lymph or of serous fluid—as meningitis, pleuritis, pericarditis, and peritonitis (particularly of puerperal women). In inflammation of the lining membrane of the air-tube, but more especially in croup, or, as it is sometimes termed, plastic inflammation of the larynx, mercury is one of our most valuable remedies; and as this disease is one which terminates rapidly, no time should be lost in getting a sufficient quantity of mercury into the system. Calomel is usually employed; but when the bowels are very irritable, the *hydrargyrum cum cretâ*, or even mercurial inunction, may be resorted to. In inflammation of the tunics of the eye, particularly iritis, mercury (next to blood-letting) is the only remedy on which much confidence can be placed; and we use it not merely with a view of putting a stop to the inflammatory action, but also in order to cause the absorption of the effused lymph[n]. In inflammation of the synovial membranes, mercury has been employed, and in some cases with manifest advantage. In dysentery, mercury has been extensively used, especially in warm climates. By some, calomel has been employed merely as a purgative (Jackson, Ballingall, Bampfield, and Annesley); by others, to produce its sialogogue effects (Johnson and Cunningham).

The *structure of the organ* influences the effect of mercury: at least it is well known that this mineral is more beneficial in inflammation of certain organs (especially those of a glandular structure, as the liver) than of others; and we refer it to some peculiarity in the structure of the part affected. In hepatitis of either temperate or tropical climates (particularly of the latter), mercury is advantageously employed[o]. Blood-letting, however, should be premised, particularly in the disease as usually met with in this country. In peripneumonia, more especially when hepatization has taken place, the best effects have sometimes resulted from its use; of course after the employment of blood-letting. When hepatization has taken place, Dr. Davies[p] recommends the use of blue pill and opium. In inflammation of the substance of the brain, also, mercury may be advantageously resorted to, after the usual depletives.

The *nature* or *quality of the inflammation* also influences the effects, and thereby the uses, of mercury. Thus, in syphilitic inflammation, mercurials are of the greatest utility; less so in rheumatic inflammation; still less in scrofulous; and most decidedly objectionable in cancerous or scorbutic diseases. The treatment of rheumatism by calomel and opium was proposed by Dr. Hamilton[q], and has found many supporters[r]; and, undoubtedly, when the febrile action does not run too high, or when the pericardium becomes affected, calomel and opium, preceded by blood-letting, will be found serviceable. It appears to be best adapted to the fibrous or diffuse form of the disease, and to fail in the synovial [s]. The scrofulous habit is, for the most part, unfavourable to the use of mercury given as a sialogogue, but there are cases in which it is not only admissible but serviceable—as scrofulous ophthalmia, when of an acute kind. In all maladies of a malignant character (as cancers, fungoid disease, &c.) mercurials are highly objectionable.

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[n] Lawrence, *Lectures on Diseases of the Eye*, in *Lancet*, vol. x. p. 198; Mackenzie, *On Diseases of the Eye*, 2d ed. pp. 389, 394, 503.

[o] Sir James M'Grigor, *Medical Sketches*; Johnson, *On Tropical Climates*; Annesley, *On Diseases of India.*

[p] *Lectures on Diseases of the Lungs*, &c. p. 191.

[q] *Op. cit.*

[r] *Vide* Dr. Hope, *Lond. Med. Gaz.* xix. 815.

γ. *Venereal diseases.*—It was formerly the opinion of surgeons that the symptoms of the venereal diseases were progressive, and never disappeared until mercury was administered; but it has, of late years, been clearly proved that this notion is erroneous: and we are indebted to some of our army surgeons—namely, to Messrs. Ferguson, Rose, Guthrie [t], Hennen [u], and Bacot [v], and to Dr. Thomson [w]—for showing that the venereal disease, in all its forms, *may* be cured without an atom of mercury. Moreover, it is fully established by the experience of almost every surgeon, that while in some instances mercury exercises a beneficial influence hardly to be observed with respect to any other disease or any other remedy, yet, that in some cases it acts most injuriously; and it is generally supposed that many of the bad venereal cases formerly met with arose, in great part, from the improper use of mercury. It is a point, therefore, of considerable importance, to determine what cases are best adapted for a mercurial, and what for a non-mercurial, method of treatment; for in admitting the *possibility* of a cure without this agent, it is not to be inferred that the method is either *eligible* or *expedient*; nay, the very persons who have proved the possibility, admit that in some cases this mineral, given so as to excite moderate salivation, is advisable. One fact is, I think, tolerably well established—viz. that the cure of venereal diseases without the aid of mercury is much slower and less secure against relapses than by a mercurial treatment [x]. It is not easy to lay down rules to guide us in the selection of the one or the other of these methods of treatment. Mr. Carmichael [y] relies principally on the eruption, and, next to this, on the appearance of the primary ulcer; and of the four forms of the venereal disease which he has described, namely, the *papular*, the *pustular*, the *phagedenic*, and the *scaly*, full courses of mercury are required, he says, in one only—namely, the scaly; in which the primary sore is the Hunterian chancre or callous ulcer, and the eruption partakes of the characters of lepra or psoriasis. But it has been satisfactorily proved by experiments made in the military hospitals, that even this scaly form of the disease may get well without mercury; and, on the other hand, in the pustular and papular forms, mercury is often a most valuable agent. Hennen, Rose, Guthrie, and Thomson, advise the employment of moderate quantities of mercury whenever the disease does not readily subside under the use of ordinary methods of treatment. But unless some special circumstances contra-indicate the use of mercury, it is, I think, advisable to affect the mouth slightly in most forms of the disease.

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[s] Dr. Macleod, *Lond. Med. Gaz.* xxi. 361.

[t] *Med. Chirurg. Trans.* vols. iv. and viii.

[u] *Military Surgery.*

[v] *On Syphilis*, 1821.

[w] *Ed. Med. and Surg. Journ.* xiv.

[x] *Vide* Colles, *Practical Observations on the Venereal Disease*, p. 318.

[y] *On Venereal Diseases*, 2d ed. 1825.

The circumstances which deserve attention, as affecting the use of mercury, are numerous. The following are the principal:—

αα. *Scrofula.*—Some of the worst and most intractable forms of venereal disease occur in scrofulous subjects; and in such, mercury is in general prejudicial. I have seen numerous instances of its injurious effects. One case which fell under my notice was that of a medical student, who, after three years' suffering, died; having been made much worse on two occasions by what I conceived to be the improper use of mercury, once by his own act, and a second time by the advice of the surgeon of his family. Mr. Colles[z], however, denies the baneful influence of mercury in scrofula, and advises its use for the cure of syphilis in scrofulous subjects; but he admits that the profession generally entertain a contrary opinion.

ββ. *Condition of the primary ulcer.*—Another point deserving attention in deciding on the use of mercury, is the condition of the primary sore: if it be much inflamed, or of an irritable nature—if it be of the kind called phagedenic, or at all disposed to slough—mercury must be most carefully avoided, as it increases the disposition to sloughing. In one case that fell under my notice, a gentleman lost his penis by the improper use of mercury, under the circumstances just mentioned.

γγ. *Extreme debility with hectic fever.*—This condition is usually believed to contra-indicate the employment of mercury. But Mr. Colles[a] asserts, "that a patient affected with secondary symptoms, even though extremely attenuated, and, as it were, melting away under the effects of hectic, can with perfect safety and advantage at once commence a course of mercury; by which not only shall his venereal symptoms be removed, but at the same time his general health be re-established."

δ. *Cholera.*—Writers on the spasmodic cholera, both of this country and of India, speak for the most part favourably of the effects of mercury, especially in the form of calomel. I may refer to the works of Drs. Johnson, Venables, and Hamett, and of Messrs. Annesley, Orton, and Searle, in proof. I have met with no writers who attribute ill effects to it. Unfortunately those who advocate its use are not agreed as to the dose, or frequency of repetition; some advising it as a purgative; some as a sedative, in combination with opium; others, lastly, using it as a sialogogue. It is deserving of especial notice, that when salivation takes place, the patient in general recovers. Dr. Griffin[b], however, has shewn that this is not invariably the case. (For further information on the use of mercurials in cholera, vide *Hydrargyri Chloridum.*)

ε. *Dropsy.*—In this disease, mercurials may do either good or harm. Thus when the dropsical effusion depends on inflammation, they may be employed with the best effects, as when hydrocephalus arises from meningitis, or hydrothorax from pleuritis. When ascites is occasioned by an enlarged liver, which compresses the vena portæ, and thereby gives rise to effusion, mercurials are sometimes beneficial. On the contrary, when dropsy occurs in old subjects, and when it depends on, or is accompanied by, general debility, salivation is almost always hurtful. In granular degeneration of the kidney, characterised by an albuminous condition of the urine, its use is highly objectionable. It is of no service to the primary disorder, while its effect on the mouth is often very violent and uncontrollable. When the effusion arises from mechanical causes not removable by mercury, as obliteration of any of the venous trunks, or pressure of malignant tumors, salivation is injurious. Occasionally dropsical effusion takes place without any appreciable cause, and then, of course, if mercury be employed, it must be in part on speculation. In such cases calomel is not unfrequently employed in combination with squills or foxglove.

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[z] *Op. cit.* p. 236.

[a] *Op. cit.* p. 206.

[b] *Lond. Med. Gaz.* xxi. p. 882.

ζ. *In chronic diseases of the viscera*, especially those arising from or connected with inflammation, mercury is frequently serviceable. Thus, in enlargement or induration of the liver, in hepatization of the lungs, &c. In those diseases commonly termed malignant, as cancer and fungus hæmatodes, and also in diseases of a non-malignant character, but occurring in debilitated subjects, mercurials, given so as to excite salivation, are objectionable.

η. *In chronic diseases of the nervous system.*—Mercury has been recommended in paralysis, and on some occasions has proved exceedingly efficacious. I have seen hemiplegia, with impaired vision and hearing, headache, and cramps of the extremities, recover under the use of mercury, after blood-letting, purgatives, &c. had failed. The patient (a young man) was kept under the influence of the medicine for two months. Mr. Colles[c] has likewise found it most efficacious in paralysis. In tetanus, mania, epilepsy, hysteria, tic douloureux, and other affections of the nervous system, mercury has been used with occasional benefit.

The foregoing are some of the most important diseases against which mercurials have been successfully administered as sialogogues.

HYDRARGYRUM PURIFICATUM, D.; *Purified Mercury*. (Take of Mercury, *six parts*. Let four parts slowly distil.)—The characters of pure mercury have been already stated (p. 703). As found in commerce, mercury is usually very pure, and, therefore, the process of purification directed by the Dublin College is unnecessary. By means of a common fire, mercury may be readily distilled in an earthen retort, to which a curved earthen tube, dipping into water, is adapted. A wash-hand basin containing water answers as a receiver. The whole of the mercury may be drawn over. The object of the process is to separate this metal from lead, tin, zinc, and other metals with which it may be contaminated.

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[c] *Op. cit.* p. 327.

2. HYDRAR'GYRUM CUM CRE'TA, *L.E D.*—MERCURY WITH CHALK.

History.—This compound (called also *Mercurius alcalisatus*, or *Æthiops absorbens*) is first mentioned, I believe, by Burton, in 1738.

Preparation.—All the British Colleges give directions for its preparation.

The *London College* directs us to take of Mercury, ℥iij.; Prepared Chalk, ℥v. Rub them together until globules are no longer visible. The directions of the *Edinburgh College* are similar.

The *Dublin College* orders it to be prepared like *Hydragyrum cum Magnesiâ*, except that precipitated carbonate of lime is to be employed in the place of carbonate of magnesia.

If this powder be digested in acetic acid, the lime of the chalk is dissolved, and the carbonic acid escapes; but the greater part, if not the whole of the mercury, is insoluble in the acid, and hence it is not in the state of protoxide. If examined by a lens, the residuum is found to consist of minute separate globules, which readily whiten silver and gold, showing they are in the metallic state. Hence it is probable that the quicksilver is mechanically divided only.

Properties and Characteristics—It is a greyish powder, which effervesces on the addition of acetic acid, yielding a solution of lime, which may be distinguished by the tests for the calcareous salts already mentioned. By digestion in nitric acid, we obtain a solution known to contain mercury by the characters already detailed for the mercurial preparations generally. By heat the mercury is volatilized, leaving the chalk.

Part is evaporated by heat; what remains is colourless, and totally soluble in acetic acid with effervescence: this solution is not coloured by hydrosulphuric acid. These substances can scarcely be so diligently triturated as that no globules shall be visible. *Ph. Lond.*

Composition.—It consists of three parts of *Mercury* and five of *Chalk.*

Physiological Effects.—It is an exceedingly mild but valuable mercurial. In full doses it acts as a gentle laxative, promoting the secretion of bile and intestinal mucus, but sometimes creating a little sickness. The chalk renders it antacid. By repeated use it occasions the constitutional effects of mercury already described.

Uses.—It is a valuable remedy in *syphilis infantum.* It is frequently employed to promote and improve the secretions of the liver, pancreas, and bowels, in various disordered conditions of the digestive organs, accompanied by clay-coloured stools or purging. In strumous affections of children (especially enlarged mesenteric glands), and other chronic maladies, it is administered with great advantage as an alterative.

Administration.—To adults it is given in doses of from five grains to a scruple, or half a drachm. It should be given in the form of powder. Pills made of it, and allowed to become hard, present internally large globules of mercury. This arises from the contraction of the substance used to form the pill mass, by which the minute globules are squeezed out and coalesce. For children the dose is two or three grains. Rhubarb, carbonate of soda, or, in some cases, Dover's powder, may be conjoined with it.

2. HYDRAR'GYRUM CUM MAGNE'SIA, *D.*—MERCURY WITH MAGNESIA.

The Dublin Pharmacopœia gives the following directions for the preparation of this compound:—

Take of purified Mercury; Manna, of each, *two parts*; Carbonate of Magnesia, *one part*. Rub the Mercury with the Manna in an earthenware mortar, adding a few drops of water, that the mixture may have the consistency of a syrup, and that the metallic globules, by continued trituration, may disappear; then add, still triturating, an eighth part of Carbonate of Magnesia. To the whole, thoroughly mixed, add of warm water sixteen parts, and let the mixture be stirred; then let it rest, and, as soon as the sediment has subsided, let the liquor be decanted; repeat the washing again, and a third time, that the manna may be completely washed off; then mix with the sediment, whilst moist, the remainder of the Carbonate of Magnesia. Lastly, let the powder be dried on bibulous paper.

The manna is employed to effect the minute division of the mercury. By the water subsequently employed the manna is got rid of. The effects, uses, and doses of this preparation, are similar to those of *Hydrargyrum cum Cretâ*.

3. PIL'ULÆ HYDRAR'GYRI, *L. E. D.*—PILLS OF MERCURY.

History.—The oldest formula for mercurial pills is that of Barbarossa (at one time admiral of the Turkish fleet, and afterwards governor or king of Algiers), and which was communicated by him to Francis the First, king of Franconia, who made it public. The common name for this preparation is *Blue Pill*, or *Pilula Cærulea*.

Preparation.—The following are the directions of the British Colleges for the preparation of these pills:—

Take of Mercury, ℥ii. [*two parts*, E.]; Confection of Red Roses, ℥iij. [*three parts*, E.]; Liquorice Root, powdered [Extract of Liquorice, reduced to fine powder, *D.*], ℥i. [*one part*, E.]. Rub the mercury with the confection until globules can no longer be seen; then, the Liquorice being added, beat the whole together until incorporated. [Divide the mass into five-grain pills, *E.*].

The friction is usually effected by steam power. By trituration the metal is reduced to a finely-divided state, and becomes intimately mixed with the confection and liquorice powder.

Properties.—It is a soft mass, of a convenient consistence for making into pills, and has a dark blue colour. When rubbed on paper or glass, it ought to present no globules; but applied to gold it communicates a silvery stain.

Composition.—Three grains of this pill contain one grain of mercury.

IMPURITY.—If any sulphuric acid should have been added to the confection to brighten its colour, some subsulphate of mercury will be formed—a compound which possesses very energetic properties.

PHYSIOLOGICAL EFFECTS.—In full doses (as from five to fifteen grains) it frequently acts as a purgative. In small doses it is alterative, and, by repetition, produces the before-mentioned constitutional effects of mercurials.

USES.—The practice of giving a blue pill at night, and a senna draught the following morning, has become somewhat popular, in consequence of its being recommended by the late Mr. Abernethy, in various disorders of the chylopoietic viscera. As an alterative, in doses of two or three grains, blue pill is frequently resorted to. Lastly, it is one of the best internal agents for exciting salivation, in the various diseases for which mercury is adapted.

ADMINISTRATION.—The usual mode of exhibiting it is in the form of pill, in the doses already mentioned; but it may also be administered when suspended in a thick mucilaginous liquid. If the object be to excite salivation, we may give five grains in the morning, and from five to ten in the evening; and to prevent purging, opium may be conjoined.

4. UNGUEN′TUM HYDRAR′GYRI, *E. D.*—OINTMENT OF MERCURY.

(Unguentum Hydrargyri fortius, *L.*)

HISTORY.—Mercurial ointment was known to, and employed by, the ancient Arabian physicians—for example, Abhenguefith, Rhazes, and Avicenna: so that it has been in use certainly 1000 years. However, Gilbertus Anglicus, who lived about the commencement of the thirteenth century, was the first who gave a detailed account of the method of extinguishing mercury by fatty matters Besides its more common appellation of *Mercurial Ointment*, it was formerly termed *Blue* or *Neapolitan Ointment*.

PREPARATION.—The following are the directions for preparing it:—

Take of Mercury, lb ij.; Lard, ℥xxiij.; Suet, ℥j. First rub the mercury with the Suet and a little of the Lard until globules can no longer be seen; then add that which is left of the Lard, and mix. *L. E.*—The *Dublin College* uses equal parts of Purified Mercury and Prepared Hog's Lard.—The *Edinburgh College* observes that "This ointment is not well prepared so long as metallic globules may be seen in it with a magnifier of four powers.

To promote the extinction of the mercury, the metal should be previously triturated with some old mercurial ointment. Rancid lard also assists the extinction of the globules.

The mercury is in a finely-divided metallic state. Guibourt[d] states, that by digesting ether on mercurial ointment, the fatty matter may de dissolved, and liquid mercury obtained in equal weight to that used in making the ointment. Mr. Donovan, however, thinks that part of the mercury attracts oxygen, and that the oxide thus formed unites with the fatty matter. I have seen no satisfactory explanation of the efficacy of old mercurial ointment in extinguishing the mercury; Guibourt offers the following:—By trituration, both lard and mercury assume oppositely electrical states, the lard becoming negative, the mercury positive; these states, he supposes, determine a more intimate mixture of the particles, and a greater division of the mercury. Now rancid lard and old mercurial ointment, having attracted oxygen from the air, more readily take on the negative condition, and hence their efficacy in promoting the extinction of the mercurial globules. Guibourt also asserts, that mortars of marble or wood are better adapted for making this ointment than those of metal, on account of their power of conducting electricity being less.

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[d] *Pharm. Raisonnée*, ii. 140.

PROPERTIES.—It is an unctuous fatty body of a bluish grey colour, and if properly prepared, gives no traces of globules when rubbed on paper, and examined by a magnifier of four powers; but when rubbed on gold, it quickens it. Moreover, if examined by a powerful microscope, innumerable globules are observed. I found the sp. gr. of a sample, obtained from Apothecaries' Hall, to be 1·7813 at 60° F. Two other samples, procured from two respectable houses, had respectively a sp. gr. of 1·6602 and 1·7603. Mr. Hennell informs me that mercurial ointment should be kept in a moderately warm situation during the winter season, for that when exposed to great cold the mercury separates in a liquid form, by the crystallization, I presume, of the fatty matter.

COMPOSITION.—This compound contains half its weight of mercury.

STRENGTH AND PURITY.—Mercurial ointment is frequently prepared with a smaller proportion of mercury than that directed to be used in the pharmacopœias; and in order to communicate to it the requisite shade of colour, sesquisulphuret of antimony, indigo, or Prussian blue, is sometimes intermixed.

In order to ascertain the strength and purity of a given sample, it is desirable to obtain a standard by way of comparison. I have always used, for this purpose, the ointment prepared at Apothecaries' Hall, London.

The qualities which should be attended to, in order to judge of a suspected sample, are its colour, and its appearance under a magnifier of four powers, as well as under a powerful microscope. By the latter we judge of the size of the globules, their number, and the presence of foreign particles. Its sp. gr. should then be observed[e]. The fatty matter should afterwards be separated from the mercury, and the latter carefully weighed. This is to be effected by means of ether or turpentine. To separate completely the fatty matter, Mr. C. Watt[f] gives the following directions:—Having first melted the fatty matter with boiling water, and allowed it to stand till the greater part of it floated on the surface, pour off the fluid fat, and then boil this mercury in a dilute solution of soap [or caustic alkali] until the metal collects in one globule.

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[e] The specific gravity of mercurial ointment may be ascertained by weighing a lump of it rolled in a globular form, and suspended by a horse-hair from the bottom of a scale-pan, first in air and then in water. Divide its weight in air by the loss experienced by weighing it in water, and the product will be its sp. gr. Thus suppose the weight in air to be 120 grs., and the weight in water, 113·25 grs.; the loss is 120—113·25 = 6·75 grs. Then divide 120 by 6·75, and the product is 1·77, the sp. gr.

[f] *The Chemist*, No. xiv., Feb. 1840.

Physiological Effects.—Mercurial ointment possesses very little power of irritating the parts to which it is applied; but when either swallowed or rubbed into the integuments, readily produces the constitutional effects of mercury. Thus Cullerier says, that three or four pills, containing each two grains of this ointment, and taken successively, have often sufficed to excite violent salivation. He also tells us, that if the object be to produce ptyalism in a very short space of time, we may effect it by giving half a drachm of the ointment in the space of twenty-four hours.

When rubbed on the skin it is capable of producing the before-mentioned constitutional effects of mercurials: and if the lard which it contains be not rancid, no obvious local effect is usually produced. Applied to ulcerated surfaces, mercurial ointment is a stimulant, and in syphilitic sores is oftentimes a very useful and beneficial application.

Uses.—It is rarely or never administered *internally* in this country, but has been much used on the continent, and with great success. It certainly well deserves a trial where the system appears insusceptible to the influence of mercury; for Cullerier says, the difficulty with him has been rather to check than to excite salivation by it.

Applied *externally*, it is employed either as a local or constitutional remedy. Thus, as a *local* agent it is used as a dressing to syphilitic sores, and is rubbed into tumors of various kinds (not those of a malignant nature, as cancer and fungus hæmatodes), with the view of causing their resolution. Sometimes, also, it is employed to destroy parasitic animals on the skin. As a *means of affecting the constitution* we use mercurial inunctions in syphilis, in inflammatory diseases, and, in fact, in all the cases (already noticed) in which our object is to set up the mercurial action in the system, more especially when the irritable condition of the digestive organs offers an objection to the internal employment of mercurials. It may be laid down as a general rule, that mercury may be used with more safety by the skin than by the stomach; but reasons of convenience, which I have already alluded to, frequently lead us to prefer its internal use.

Administration.—*Internally*, it is given in doses of from two to five grains, made into pills, with either soap or some mild powder, as liquorice. *Externally*, when the object is to excite very speedy salivation, half a drachm may be rubbed into the skin every hour, washing the part each time, and varying the seat of application. If, however, it be not desirable or necessary to produce such a speedy effect, half a drachm or a drachm, rubbed in night and morning, will be sufficient. During the whole course of inunction the patient should wear the same drawers night and day.

When the friction is performed by a second person, the hand should be enveloped with soft oiled pig's bladder, turned inside out[g]. Mercurial frictions ought not to be violent, but long continued, and had better be carried on near a fire, in order to promote the liquefaction and absorption of the ointment. In syphilis, and other diseases in which our sole object is the constitutional affection, it matters little to what part of the body the ointment is applied, provided the cuticle be thin (for this inorganized layer offers an impediment to absorption in proportion to its thickness). The internal parts of the thighs are usually, therefore, selected. However, in liver complaints, the inunctions are made in the region of the organ affected. The occasional use of the warm bath promotes absorption when the ointment is applied to the skin.

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[g] Colles, *op. cit.* p. 42.

1. **UNGUENTUM HYDRARGYRI MITIUS**, L. D. *Milder Mercurial Ointment.* (Stronger Mercurial Ointment, lbj.; Lard, lbij. Mix. *L.*—The *Dublin College* orders it to be made with double the weight of Lard.—The *Edinburgh College* merely observes, that "the mercurial ointment, with the proportions here directed [see p. 725], may be diluted at pleasure with twice or thrice its weight of axunge").—This preparation is applied as a dressing to ulcers and cutaneous diseases.

2. **CERATUM HYDRARGYRI COMPOSITUM**, L. *Compound Cerate of Mercury.* (Stronger Ointment of Mercury; Soap Cerate, each ℥iv.; Camphor, ℥j. Rub them together until they are incorporated).—Employed as a resolvent application to enlarged joints and indolent tumors. This preparation was introduced into the pharmacopœia on the recommendation of Mr. Scott[h].

3. **LINIMENTUM HYDRARGYRI COMPOSITUM**, L. *Compound Liniment of Mercury.* (Stronger Ointment of Mercury; Lard, each ℥iv.; Camphor, ℥j.; Rectified Spirit, fʒj.; Solution of Ammonia, f℥iv. Rub the Camphor first with the Spirit, then with the Lard and Ointment of Mercury; lastly, the Solution of Ammonia being gradually poured in, mix them all.)—It is used (by way of friction) in chronic tumors, chronic affections of the joints, &c., where the object is to excite the action of the lymphatic vessels. It is said to cause salivation more readily than the common mercurial ointment, owing to the camphor and ammonia.

5. EMPLAS'TRUM HYDRAR'GYRI, *L. E.*—PLASTER OF MERCURY.

Both the London and Edinburgh Colleges give formulæ for the preparation of this plaster.

The *London College* orders of Mercury, ℥iij.; Plaster of Lead, lbj.; Olive Oil, fʒj.; Sulphur, grs. viij. To the heated Oil add the Sulphur gradually, stirring constantly with a spatula until they incorporate; afterwards rub the Mercury with them until globules are no longer visible; then gradually add the Plaster of Lead, melted with a slow fire, and mix them all.

In this process the sulphur of the sulphurated oil (see p. 463) unites with part of the mercury. The remainder of the metal becomes mechanically divided.

The *Edinburgh College* orders of Mercury, ℥iij.; Olive Oil, fʒix.; Resin, ℥j.;

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[h] *Surgical Observations on the Treatment of Chronic Inflammation in various Structures, partic rly as exemplified in Diseases of the Joints.* Lond. 1828.

Litharge Plaster, ʒvj. Liquefy together the oil and resin, let them cool, add the mercury, and triturate till its globules disappear; then add to the mixture the plaster previously liquefied; and mix the whole thoroughly.

It is supposed to stimulate the lymphatic vessels of the parts to which it is applied, and is used as a discutient in glandular enlargements and other swellings, whether venereal or otherwise, and also to the region of the liver in hepatic complaints. Dr. Wilson Philip[h] has seen it induce salivation.

EMPLASTRUM AMMONIACI CUM HYDRARGYRO, L. D. *Emplastrum Ammoniaci et Hydrargyri*, E. *Plaster of Ammoniacum with Mercury.* (Ammoniacum, lbj.; Mercury, ℥iij.; Olive Oil, fʒj.; Sulphur, grs. viij. To the heated Oil gradually add the Sulphur, stirring constantly with a spatula until they incorporate; then rub the Mercury with them until globules are no longer visible; lastly, gradually add the Ammoniacum, melted, and mix them all. *L. E.*—The *Dublin College* orders purified mercury; and, instead of the olive oil and sulphur, directs two drachms of Common Turpentine to be used.)—It is a more powerful compound than the preceding, and is employed in the same cases, especially to disperse venereal buboes.

6. HYDRAR′GYRI OX′YDUM, *L.*—OXIDE OF MERCURY.

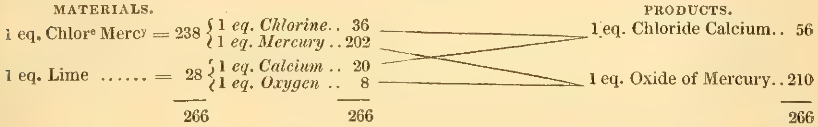
(Hydrargyri Oxydum nigrum, *D.*)

History.—The mode of preparing this compound was taught by Moscat, in 1797. This oxide is sometimes termed the *Protoxide*, *Suboxide*, *Ash*, *Grey*, or *Black Oxide* (*Hydrargyri Oxydum cinereum*, *Hydrargyri Oxidum nigrum*).

Preparation.—The following are the directions of the London and Dublin Colleges for its preparation:—

The *London College* orders of Chloride of Mercury, ʒj.; Lime Water, *Cong.* j. Mix and frequently shake them. Set by, and when the oxide has subsided, pour off the liquor. Lastly, wash it in distilled Water until nothing alkaline can be perceived, and dry it, wrapped in bibulous paper, in the air.

In this process double decomposition takes place: chloride of calcium is formed in solution, while oxide of mercury precipitates.



The following is the process of the *Dublin College*:—

Take of Sublimed Calomel, one part; Water of Caustic Potash, made warm, four parts. Let them be triturated together until an oxide of a black colour is obtained, and let this be frequently washed with water: lastly, let the oxide be dried with a *medium* heat on bibulous paper.

In this process the reactions are similar to those of the preceding one; but as potash is used instead of lime, the products are chloride of potassium in solution, and oxide of mercury precipitated.

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[h] *Op. cit.*

PROPERTIES.—Pure oxide of mercury is black, or nearly so. The present preparation, however, is frequently greyish, owing to the presence of some undecomposed calomel. It is readily decomposed by light (especially by the solar rays), becomes olive-coloured, and is resolved into metallic mercury and the binoxide. It is odourless, tasteless, insoluble in water and the alkalis, but is soluble in nitric and acetic acids. By the action of hydrochloric acid it forms water and calomel. When heated it is first decomposed, and then completely dissipated.

Characteristics.—Heated in a glass tube it evolves oxygen, while metallic globules are sublimed. Dissolved in diluted nitric acid it forms a protomercurial salt, known by the before-mentioned characters for these substances.

COMPOSITION.—The composition of this oxide is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Sefström.*
Mercury	1	202	96·19	96·2
Oxygen	1	8	3·81	3·8
Oxide of Mercury	1	210	100·00	100·0

PURITY.—Digested, for a short time, in dilute hydrochloric acid, the solution, when filtered, should form no precipitate with either potash or oxalate of ammonia. If any binoxide had been dissolved, the potash would throw it down as a reddish or yellowish hydrate. If any carbonate of lime had been precipitated, the oxalate would recognise it.

Digested for a short time with diluted hydrochloric acid and strained, neither solution of potash nor oxalate of ammonia throws down any thing. It is totally soluble in acetic acid. By heat it is entirely dissipated. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS.—Pure oxide of mercury is one of the least irritating of the mercurial preparations, and, therefore, when swallowed, does not produce much disorder of the alimentary canal. In small doses it acts as an alterative and purgative. When taken in repeated doses, its constitutional effects are similar to those of other mercurials.

USES.—Mr. Abernethy employed it as a fumigating agent. The following are his directions for using it:—Place the patient in a vapour bath, in a complete suit of under garments, with a cloth around his chin. Two drachms of the oxide are then to be put on a heated iron within the machine in which the patient is sitting. After continuing in the bath for about fifteen or twenty minutes, the body is found to be covered with a whitish powder. The patient should be placed in bed, and lie in the same clothes till morning, and then go into a tepid bath. By this mode of proceeding, Mr. Abernethy says, he has known salivation induced in forty-eight hours.

Oxide of mercury is rarely employed as an internal remedy; indeed, its varying composition is a strong objection to its use. As an external application it has been used in the form of *Ointment* (composed of one part of oxide and three parts of lard), and also suspended in a weak solution of chloride of calcium, under the name of *Black Wash.*

Administration.—For internal use the dose is from half a grain to two or three grains.

LOTIO NIGRA (*Black Wash; Aqua Mercurialis nigra; Aqua Phagedænica mitis*).—This is prepared by adding calomel to lime-water. The proportions of the ingredients may be varied, but in general one drachm of calomel is used to a pint of lime-water. Oxide of mercury precipitates, and chloride of calcium remains in solution. As the efficacy of the wash depends on the oxide, the bottle must be well shaken every time of using it. This compound is a favourite application to venereal sores of almost all kinds,—in most being serviceable, in few or none being hurtful.

7. HYDRAR'GYRI BINOX'YDUM, *L.*—BINOXIDE OF MERCURY.

(Hydrargyrum Oxydum rubrum, *D.*)

History.—This is the *Peroxide* or *Red Oxide of Mercury* of some writers. Geber[1] describes the method of making that variety of it which is prepared by calcination, and which was formerly called *Red Precipitate per se* (*Mercurius Præcipitatus ruber per se*) or *Calcined Mercury* (*Hydrargyrum calcinatum*). He calls it *Coagulated Mercury.*

Preparation.—This compound may be prepared either by precipitation or by calcination.

The *London College* directs it to be prepared by precipitation; and orders of Bichloride of Mercury ℥iv.; Solution of Potash f℥xxviij.; Distilled Water Ovj. Dissolve the Bichloride of Mercury in the Water; strain, and add the Solution of Potash. The liquor being poured off, wash, in distilled water, the powder thrown down, until nothing alkaline can be perceived, and dry it with a gentle heat.

In this process one equivalent or 274 parts of bichloride of mercury are decomposed by two equivalents or 96 parts of potash, and yield one equivalent or 218 parts of binoxide of mercury, and two equivalents or 152 parts of chloride of potassium.

MATERIALS.				PRODUCTS.	
1 eq. Bichl^{de} Mercury..	274	*2 eq. Chlorine..*	72	2 eq. Chloride Potassium..	152
		1 eq. Mercury..	202		
1 eq. Potash	96	*2 eq. Potassium*	80		
		2 eq. Oxygen ..	16	1 eq. Binoxide of Mercury	218
	370		370		370

The *Dublin College* orders it to be prepared by calcination as follows:—Take of purified mercury any required quantity, passed into a glass vessel with a narrow mouth and broad bottom; let it be exposed to a heat of about 600° F. until it is converted into red scales.

The heat vapourizes the mercury, which in this state attracts oxygen from the air, and forms this red or binoxide. The long neck of the vessel prevents the escape of the vapours or newly-formed oxide.

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[1] *Sum of Perfection,* book i. part iv. ch. 16.

The process is a very tedious one, occupying several weeks; so that Geber's remark was correct, that "it is a most difficult and laborious work, even with the profoundness of clear-sighted industry." The apparatus which Mr. Boyle contrived for the manufacture of it, was long termed "*Boyle's Hell*," from a notion that the mercury was tortured in it.

Properties.—When prepared by precipitation it is in the form of an orange-red powder: but when made by calcination, occurs in small brilliant scales of a ruby red colour. Both varieties agree in the following properties:—They are odourless, have an acrid metallic taste, are very slightly soluble in water[j], but readily soluble in both nitric and hydrochloric acids. They are decomposed and reduced by heat and solar light: the precipitated variety is more readily acted on by solar light than the variety made by calcination.

Characteristics.—When heated in a glass tube by a spirit lamp, it is decomposed into oxygen and mercury: the first may be recognised by a glowing match, the second condenses in small globules. It dissolves completely in hydrochloric acid: the solution contains bichloride of mercury, which may be known by the tests hereafter to be mentioned for this substance (vide *Hydrargyri Bichloridum*).

Composition.—The composition of this substance is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Sefström.*	*Donovan.*
Mercury	1	202	92·66	92·68	92·75
Oxygen	2	16	7·34	7·32	7·25
Binoxide of Mercury	1	218	100·00	100·00	100·00

Binoxide of mercury prepared by precipitation usually contains some water.

Purity.—Binoxide of mercury should be completely dissipated by heat, and be insoluble in water. Its solution in nitric acid should be unaffected by nitrate of silver, by which the absence of any chloride is shown. If an insufficient quantity of potash be employed in the preparation of the precipitated variety, the product is brownish or brick-dust coloured, and contains oxychloride of mercury (composed, according to Souberain, of 1 eq. bichloride of mercury, and 3 eqs. of binoxide[k].)

On the application of heat it yields oxygen, and the mercury either runs into globules, or is totally dissipated. It is entirely soluble in hydrochloric acid. ***Ph. Lond.***

Physiological Effects.—Binoxide of mercury is a powerful irritant, and when taken internally, even in small doses, readily excites vomiting and purging: large doses excite gastro-enteritis. Orfila[l] found that binoxide, obtained by precipitation from four grains of bichloride, killed a dog in eighteen minutes. The constitutional effects of this preparation are the same as those of mercurials generally.

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[j] *Journ. de Pharm.* t. xxiv. p. 252.

[k] Dumas, *Traité de Chimie,* iii. 615.

[l] *Toxicol. Gén.*

USES.—Binoxide of mercury is rarely employed as a medicine. It has been applied as an escharotic, either in the form of powder or ointment. Internally it was formerly exhibited to excite salivation in venereal diseases, but is objectionable, especially where the bowels are morbidly irritable. It is rarely or never used now.

In pharmacy it is employed in the preparation of bicyanide of mercury (vide *Hydrargyri Bicyanidum*).

ADMINISTRATION.—The dose of it is from a quarter of a grain to a grain, given in the form of pill, in combination with opium.

LOTIO FLAVA: *Lotio* (seu *Aqua*) *Phagedænica; Yellow* or *Phagedenic Wash.*—This compound, which was formerly in frequent use, is prepared by adding bichloride of mercury to lime-water. The proportions vary in different formulæ. The quantity of bichloride should not, I think, exceed two grains to an ounce of lime-water: the usual proportions are thirty grains of bichloride to sixteen ounces of lime-water. The preparation, then, consists of the yellow hydrated binoxide of mercury (which precipitates), chloride of calcium, and caustic lime; the two latter being in solution. But if the quantity of bichloride exceed $3\frac{7}{10}$ grains to an ounce of lime-water, the precipitate is brown or brickdust coloured, and contains oxychloride of mercury, while the clear liquor holds in solution some hydrargyro-chloride of calcium; that is, a saline combination, in which chloride of calcium is the base, and bichloride of mercury the acid[m]. Yellow or phagedenic wash is applied, by means of lint, to venereal and scrofulous ulcers. Dr. Hintze[n] used it with advantage in chronic ulcers which succeed to burns. It should be well shaken, and used in the turbid state.

8. HYDRAR'GYRI NI'TRICO-OX'YDUM, *L.*—NITRIC OXIDE OF MERCURY.

(Hydrargyri Oxidum rubrum, *E.*—Hydrargyri Oxydum nitricum, *D.*)

HISTORY.—This preparation was known to Raymond Lully in the latter part of the thirteenth century. It is commonly termed *Red Precipitated Mercury* (*Mercurius Precipitatus ruber*), or, for brevity, *Red Precipitate*.

PREPARATION.—All the British Colleges give directions for the preparation of this oxide.

The *London College* orders of Mercury, lbiij.: Nitric Acid, lbiss.; Distilled Water, Oij. Mix them in a proper vessel, and apply a gentle heat until the mercury is dissolved. Boil down the liquor, and rub what remains to powder. Put this into another very shallow vessel; then apply a slow fire, and gradually increase it until red vapour ceases to arise.

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[m] Guibourt, *Journ. Chim. Méd.* iii. 377; also *Pharm. Raisonnée*, i. 563; and Souberain, *Nouv. Traité de Pharm.* ii. 529.

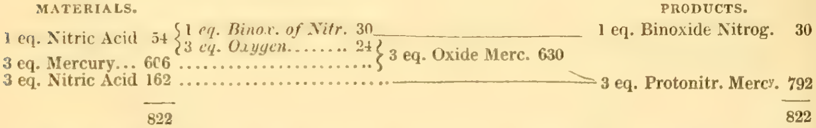
Brit. and For. Med. Rev. April, 1836.

The *Edinburgh College* directs of Mercury, ℥viij.; Diluted Nitric Acid (*D.* 1820) f℥v. Dissolve half of the mercury in the acid, with the aid of a moderate heat; and continue the heat till a dry salt is formed. Triturate the rest of the mercury with the salt till a fine uniform powder be obtained; heat the powder in a porcelain vessel, and constantly stir it till acid fumes cease to be discharged.

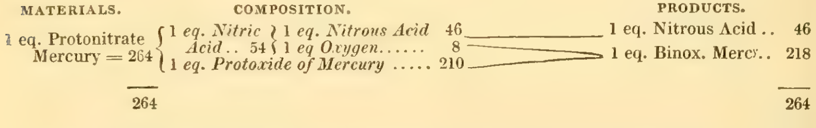
The *Dublin College* orders of purified Mercury, two parts; Diluted Nitric Acid, three parts. Let the mercury be dissolved, and let heat be applied until the dried mass passes into red scales.

This compound is best prepared on the large scale, for it cannot be so well procured of the bright orange-red colour, and crystalline or scaly appearance, usually considered desirable, when only small quantities of materials are employed. Some advise a larger quantity of nitric acid to be employed than is directed in the London Pharmacopœia. The reduction of the nitrate to powder is objectionable, as it diminishes the crystalline appearance of the oxide. Mr. Brande[o] says, "the nitrate requires to be constantly stirred during the process, which is usually performed in a cast-iron pot." But in general a shallow earthen dish is employed, with a second one inverted over it, and care is taken not to disturb the nitrate during the operation. The heat of the sand-bath is employed. Indeed, some have asserted, that the finest product is obtained when the calcination is performed in the same vessel in which the nitrate was formed, and without stirring, as directed in the Dublin Pharmacopœia[p].

When quicksilver and the diluted nitric acid are digested together, the metal is oxidized at the expense of part of the acid, while binoxide of nitrogen escapes, and, combining with oxygen of the air, becomes nitrous acid. The oxidized metal unites to some undecomposed nitric acid to form a nitrate. The following diagram explains the formation of the protonitrate:—



When nitrate of mercury is heated, decomposition takes place: the nitric acid yields oxygen to the protoxide of mercury, which thereby becomes binoxide of mercury, while nitrous acid (or its elements) escapes.



Some pernitrate of mercury usually remains undecomposed, but the quantity is small. Mr. Brande states, that 100 pounds of mercury and

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[o] *Manual of Chemistry.*

[p] Dr. Barker, *Observ. on the Dublin Pharmacopœia.*

48 pounds of nitric acid (sp. gr. 1·48), yielded 112 pounds of nitric oxide of mercury. Hence three pounds of nitric acid must have remained in combination with the oxide.

PROPERTIES.—It occurs in bright tile-red, or scarlet, crystalline grains or scales. Dr. Barker[q] found that 1000 parts of water took up 0·62 of this oxide. The other properties and characteristics of this compound are the same as those of the last-mentioned preparation (vide *Hydrargyri Binoxydum*).

PURITY.—The presence of some undecomposed nitrate may be recognised by heating the suspected nitric oxide of mercury, when nitrous vapours are evolved, and by boiling in water, when a solution is obtained, from which lime-water and hydrosulphuric acid throw down precipitates. The nitric oxide of mercury is completely dissipated by heat: hence the presence of non-volatile matters (as red lead) might be readily detected. Heated before the blow-pipe on charcoal, the mercurial oxide is reduced and dissipated, but if red lead be present, globules of metallic lead will be left behind.

On the application of heat no nitric vapour is emitted. Neither lime-water nor hydrosulphuric acid throws down any thing from the water in which it has been boiled. In other respects it resembles the preceding preparation. *Ph. Lond.*

Entirely soluble in muriatic acid: heat decomposes and sublimes it entirely in metallic globules, without any discharge of nitrous fumes. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Its local action is that of a powerful irritant (vide *Hydrargyri Binoxydum*). But the presence of nitrate of mercury in the nitric oxide renders its topical action more energetic. Its constitutional effects are the same as those of other mercurials.

Fabricius Hildanus, Bartholinus, Langius, and Jacobs[r], have reported cases in which the external use of this agent gave rise to salivation and other constitutional effects of mercury. In the case mentioned by Jacob, death resulted from the application of it to a wart on the face.

Frederic Hoffman, Ploucquet, Girtanner[s], and more recently Mr. Brett[t], have related instances of poisoning by its internal employment.

USES.—Internally it has been administered in the form of pill in venereal diseases, but the practice is highly objectionable.

As an external agent it is used in the form of powder (obtained by levigation) or ointment; the latter is officinal. As a caustic, it is sprinkled over spongy excrescences, venereal warts, chancres, indolent fungous ulcers, &c. Mixed with eight parts of finely-powdered white sugar, it is blown into the eye with a quill in opacity of the cornea[u].

UNGUENTUM HYDRARGYRI NITRICO-OXYDI, L.; *Unguentum Oxidi Hydrargyri*, E.; *Unguentum Hydrargyri Oxydi Nitrici*, D. (Finely-powdered Nitric Oxide of Mercury, ℥j.; White Wax, ʒij.; Lard, ʒvj. Mix. *L. D.*—The *Edinburgh College* employs Nitric Oxide of Mercury, ℥j.; Lard, ʒviij.)—This ointment undergoes decomposition by keeping; its colour changing from red to grey, in consequence of the partial deoxidation of the nitric oxide of mercury. Dr. Duncan[v] says the presence of resin quickly causes it to become black. It is a valuable stimulant, and is frequently applied to indolent sores and ulcers, when we require to increase the quantity, and improve the quality, of the discharge: to inflamed eye-lids (*ophthalmia tarsi*); chronic conjunctivitis, &c.

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[q] *Op cit.*

[r] Quoted by Wibmer, *Wirkung d. Arzneim.* iii. 69.

[s] Wibmer, *op. cit.*

[t] *Lond. Med. Gaz.* xiii. 117. A case of poisoning with it is also recorded in the *Lancet* for 1836-37, vol. i. p. 401.

[u] Mackenzie, *On Diseases of the Eye*, 2d edit. p. 584.

9. HYDRAR'GYRI CHLO'RIDUM, *L.*—CHLORIDE OF MERCURY OR CALOMEL.

(Calomelas, *E.*—Calomelas sublimatum; and Calomelas præcipitatum, *D.*)

History.—Beguin in 1608, and Oswald Croll in 1609, are the first Europeans who mention this compound. Mr Hatchett[w] says it had been long known to the natives of Thibet. Its discoverer is unknown. It has had a great variety of names. The term *Calomel* (*Calomelas*, from καλὸς, *good*, and μέλας, *black*) was first used by Sir Theodore Turquet de Mayenne[x] (who died in 1655), in consequence, as some say, of his having had a favourite black servant who prepared it; or, according to others, because it was a *good* remedy for the *black* bile. *Drago mitigatus*, *Aquila alba*, *Manna Metallorum*, and *Panchymagogum minerale*, are some of the appellations for it. *Mercurius dulcis*, *Hydrargyrum muriaticum mite*, *Submuriate of Mercury*, and *Subchloride*, *Protochloride*, or *Dichloride of Mercury*, are some of the more modern synonymes of it.

Natural History.—*Native Calomel* or *Corneous Mercury* occurs in crusts, and also crystallized in four-sided prisms terminated by pyramids. It is found at Deux-Ponts, Carniola, and in Spain.

Preparation.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Mercury, lbiv.; Sulphuric Acid, lbiij.; Chloride of Sodium, lbiss.; Distilled Water, as much as may be sufficient. Boil two pounds of the Mercury with the Sulphuric Acid in a proper vessel, until the Bipersulphate of Mercury remains dry; rub this when it is cold with (the remaining) two pounds of Mercury in an earthen mortar, that they may be perfectly mixed. Afterwards add the Chloride of Sodium, and rub them together, until globules are no longer visible; then sublime. Rub the sublimate to very fine powder, and wash it carefully with boiling distilled water, and dry it.

The *Edinburgh College* directs of Mercury, ʒviij.; Sulphuric Acid (commercial), fʒij. and fʒiij.; Pure Nitric Acid, fʒss.; Muriate of Soda, ʒiij. Mix the acids, add four ounces of the mercury, and dissolve it with the aid of a moderate heat. Raise the heat so as to attain a dry salt. Triturate this with the Muriate of Soda and the rest of Mercury till the globules entirely disappear. Heat the mixture by means of a sand-bath in a proper subliming apparatus. Reduce the sublimate to fine powder; wash the powder with boiling distilled water until the water ceases to precipitate with solution of iodide of potassium; and then dry it.

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[v] *Edinb. Dispensatory.*

[w] Brande's *Manual of Pharmacy*, 2d edit. 328.

[x] *Annals of Philosophy*, vol. ii. N. S. p. 427.—See also the old series of this journal, vol. xvi. pp. 309, 394, and 426.

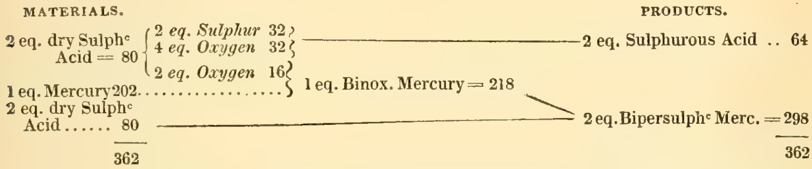
The *Dublin College* gives the following formula for the preparation of the bipersulphate of mercury (*Hydrargyri Persulphas*, D.):—

Take of Purified Mercury; Sulphuric Acid, of each, *six parts;* Nitric Acid, *one part.* Let them be exposed to heat in a glass vessel, and let the fire be increased until the thoroughly dried residue shall have become white.

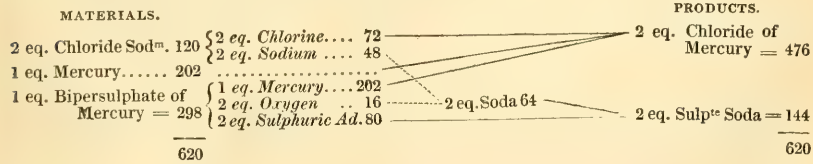
From this, bipersulphate of mercury, Sublimed Calomel (*Calomel sublimatum*, D.) is thus directed to be prepared:—

Take of Persulphate of Mercury, *twenty-five parts;* Purified Mercury, *seventeen parts;* Dried Muriate of Soda, *ten parts.* Let the Persulphate of Mercury and purified Mercury be triturated together in an earthenware mortar, until the metallic globules shall have completely disappeared; then let the dried Muriate of Soda be added: let them be well mixed, and in a suitable vessel, with a heat gradually raised, let them be sublimed into a receiver; let the sublimed mass be reduced to powder and washed with water, so long as the decanted liquor, on addition of water of Caustic Potash, shall exhibit any deposition; lastly, let the sublimed calomel be dried.

In the first stage of this process one equivalent or 202 parts of mercury decompose two equivalents or 80 parts of dry sulphuric acid; and, abstracting two equivalents or 16 parts of oxygen, to form one equivalent or 218 parts of binoxide of mercury, disengage two equivalents or 64 parts of sulphurous acid. The binoxide combines with two equivalents or 80 parts of undecomposed sulphuric acid, and forms one equivalent or 298 parts of bipersulphate of mercury.


MATERIALS.
PRODUCTS.
2 eq. dry Sulph^c Acid = 80
2 eq. Sulphur 32
4 eq. Oxygen 32
2 eq. Oxygen 16
2 eq. Sulphurous Acid .. 64
1 eq. Mercury 202
1 eq. Binox. Mercury = 218
2 eq. dry Sulph^c Acid 80
2 eq. Bipersulph^c Merc. = 298
362
362

If one equivalent or 298 parts of bipersulphate, one equivalent or 202 parts of reguline mercury, and two equivalents or 120 parts of chloride of sodium, be intimately mixed and sublimed, reaction takes place, and we obtain two equivalents or 476 parts of chloride of mercury, and two equivalents or 144 parts of sulphate of soda.



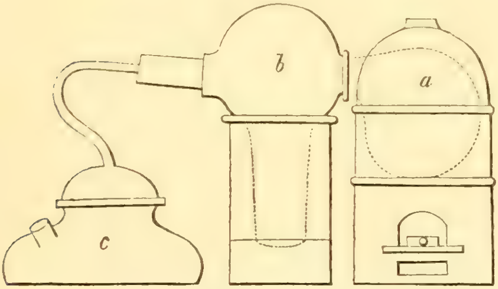
At Apothecaries' Hall, 50 lbs. of mercury are boiled with 70 lbs. of sulphuric acid to dryness in a cast-iron vessel; 62 lbs. of the dry salt are triturated with 40½ lbs. of mercury, until the globules disappear, and 34 lbs. of common salt are then added. The mixture is submitted to heat, and from 95 to 100 lbs. of sublimed calomel are obtained. It is washed in large quantities of distilled water, after having been ground to a fine and impalpable powder.

The subliming apparatus varies in different manufactories. In some it consists of a large earthen retort, with short but wide neck, opening into an earthen elliptical receiver, in the bottom of which is water. The retort is placed in sand, contained in an iron pot set in a furnace.

"The form in which calomel sublimes," observes Mr. Brande, "depends much upon the dimensions and temperature of the subliming vessels. In small vessels it generally condenses in a crystalline cake, the interior surface of which is often covered with beautiful quadrangular prismatic crystals[y], transparent, and of a texture somewhat elastic or horny: in this state it acquires, by the necessary rubbing into powder, a decidedly yellow or buff colour, more or less deep, according to the degree of trituration which it has undergone. If, on the contrary, the calomel be sublimed into a very capacious and cold receiver, it falls in a most impalpable and perfectly white powder, which requires only one elutriation to fit it for use; it then remains perfectly colourless. By a modification of the process, it may be suffered, as it sublimes, to fall into water, according to Mr. Jewell's patent.

"The above circumstances, too, account for the various appearances under which calomel occasionally presents itself in commerce: it may be added, that the buff aspect of this substance indicates the absence of corrosive sublimate; though it by no means follows as a consequence that when snow-white it contains it. When the surface of massive sublimed calomel is scratched, it always exhibits a buff colour: it also becomes yellow when heated, but loses its tint as it again cools[z].

Fig. 119.



Henry's modification of Jewell's apparatus for preparing calomel by steam (Hydrosublimate of mercury).

a. Furnace, containing an earthen retort (having a wide and short neck), in which the ingredients for making calomel are placed.
b. An earthen receiver, having three tubulures: one communicating with the retort; a second dipping into water in an earthen jar, and a third connected to a steam-pipe.
c. Steam-boiler.

Mr. Jewell's process[a] for preparing calomel consists in keeping the receiving vessel filled with steam, so that the vaporous calomel is condensed in it, and takes the form of a fine powder, which is much finer than can be ob-

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Brooke, *Annals of Philosophy.*

[z] *Manual of Chemistry*, 4th ed. p. 788.

[a] *Repert. of Arts*, xiii. 79, 2d Series.

tained by levigation and elutriation. This process has been improved by M. O. Henry (fig. 119).

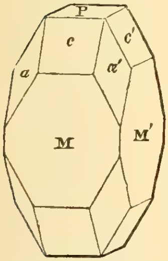
The *Dublin College* directs Precipitated Calomel (*Calomelas præcipitatum*, D.) to be thus prepared :—

Take of purified Mercury, *seventeen parts ;* diluted Nitric acid, *fifteen parts.* On the mercury passed into a glass vessel, pour the acid, and when the mixture shall have ceased to effervesce, digest with a *medium* heat [between 100° and 200° F.] during six hours, occasionally stirring it; then let the heat be increased, that the liquor may boil for a short time, and let this be poured off from the residual mercury, and quickly mixed with four hundred parts of boiling water containing seven parts of muriate of soda in solution. Let the powder which falls down be washed with warm water, so long as the decanted liquor, on addition of some drops of water of caustic potash, shall form any deposit: lastly, let it be dried.

By the mutual reaction of mercury and diluted nitric acid, a sulphate of the protoxide of mercury is formed; binoxide of nitrogen gas being evolved. Four equivalents of nitric acid and 3 eq. of mercury yield 3 equivalents of protonitrate of mercury and 1 equivalent of binoxide of nitrogen. When solutions of protonitrate of mercury and chloride of sodium are mixed, double decomposition takes place; nitrate of soda is formed in solution, while chloride of mercury is precipitated. One eq. of the protonitrate of mercury, and 1 eq. of chloride of sodium, yield 1 eq. of nitrate of soda and 1 eq. of chloride of mercury (see p. 756).

Properties.—The crystals of calomel are square prisms. The appearance of the crystalline cake of sublimed calomel has been already noticed. As met with in the shops, it is in the form of a fine odourless and tasteless powder, whose sp. gr. is 7·176 (7·2, Brande). When prepared by Jewell's process it is perfectly white, but when obtained in the ordinary way has a light buff or ivory tint. It volatilizes by heat, and, under pressure, fuses. It is insoluble in cold water and alcohol. According to Donovan[b] and others[c], calomel suffers partial decomposition by long boiling in water, and a solution is obtained which contains mercury and chlorine (bichloride of mercury ?).

Fig. 120.



Crystal of Calomel.

By exposure to light, calomel becomes dark coloured, in consequence, according to Dumas[d], of the transformation of a small portion into mercury and bichloride. Others have ascribed this change to the evolution of chlorine and combination of the metal with oxygen. Both hypotheses are inconsistent with the statement of Vogel[e], that this blackened calomel is insoluble in nitric acid. Is it not probable that the change depends on the formation of a subchloride, as Wetzlar has shewn to be the case with chloride of silver ? By digestion in hot and concentrated hydrochloric acid, we obtain bichloride of mercury and reguline mercury. Boiling sulphuric acid forms bipersulphate and bichloride of mercury, with the evolution of sulphurous acid.

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[b] *Ann. Phil.* xiv. 323.

[c] Gmelin, *Handb. d. Chemie,* i. 1299; Geiger's *Handb. d. Pharm.* by Liebig, i. 561.

[d] *Traité de Chimie,* iii. 605.

[e] Landgrebe, *Ueber das Licht,* 87.

Characteristics.—Iodide of potassium produces at first a greyish, afterwards a greenish-yellow precipitate (*iodide of mercury*). When heated in nitric acid, calomel is converted into bichloride and bipernitrate of mercury; and on the application of the tests already mentioned (p. 702) for mercurial preparations generally, we readily obtain evidence of the presence of mercury. Having thus shewn it to be a mercurial compound, we may easily prove it to be calomel by observing that it is insoluble in water, and that on the addition of lime-water a blackish grey precipitate (*protoxide of mercury*) is obtained, while the supernatant liquor yields, with nitrate of silver, a white precipitate (*chloride of silver*) insoluble in nitric acid, but soluble in ammonia. Protochloride of tin, added to calomel, abstracts the chlorine, and becomes bichloride of tin, while globules of metallic mercury are obtained.

COMPOSITION.—The following is the composition of calomel:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Turner, Davy, Zaboada.*
Mercury	1	202	84·87	85
Chlorine	1	36	15·12	15
Chloride of Mercury	1	238	99·99	100

PURITY.—When pure, calomel is completely vaporized by heat. Water or alcohol which has been digested on it, should occasion no precipitate or change of colour on the addition of lime-water, caustic potash, ammonia, nitrate of silver, or hydrosulphuric acid, by which the absence of bichloride of mercury may be inferred. I have met with calomel which, in consequence of being imperfectly washed, contained bichloride. It had been given to several patients before its purity was suspected, and had operated on them most violently. When mixed with potash it became black, like pure calomel: the quantity of bichloride being insufficient to produce any perceptible alteration in the colour of the precipitate. But water which had been digested on it, gave, with the above-mentioned tests, the characteristic indications of bichloride of mercury.

A whitish powder, which, on the addition of potash, becomes black, and then, when heated, runs into globules of mercury. It is also totally vaporized by heat. The distilled water with which it has been washed, or in which it has been boiled, gives no precipitate with nitrate of silver, lime water, nor hydrosulphuric acid. *Ph. Lond.*

Heat sublimes it without any residuum: sulphuric ether agitated with it, filtered, and then evaporated to dryness, leaves no crystalline residuum, and what residuum may be left is not turned yellow with aqua potassæ. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Wepfer[f], Viborg, Flormann[g], Gaspard[h], and Annesley[i], have examined the effects of calomel on dogs, horses, and pigs, but without any remarkable results. Viborg gave half an ounce, with six pounds of water, to a horse: the effects were cough, heaving of the flanks, quick pulse, enfeebled appetite, and in twenty-four hours loose stools. Annesley asserts, from his experiments on dogs, that large doses of calomel diminish the vascularity of the gastro-intestinal membrane.

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[f] *Hist. Cicutæ Aquat.*
[g] Wibmer, *Wirk. d. Arzn.*
[h] Magendie, *Journ. de Physiol.*
[i] *Diseases of India.*

β. On Man.—Calomel may be ranked among the mild preparations of mercury; for although, in its local action, it is somewhat more powerful than the oxide, or than those preparations which contain mercury in a finely divided state (as blue pill), yet it is much milder than any of the other salts of mercury. In *small doses*, as a few grains, it occasionally excites no obvious effects, though more commonly it acts as a purgative; and in very susceptible persons, especially females, it sometimes produces nausea, griping, and great faintness. It appears from the experience of most practitioners that adults are more susceptible of the influence of calomel than children[j]. The green stools (called *calomel stools* by Kraus) which sometimes follow the administration of calomel to children, are usually supposed to arise from the action of this medicine on the liver; though Zeller (quoted by Kraus) thinks it depends on alterations produced in the condition of the blood; and Kraus[k] is disposed to refer it to the operation of calomel on the milk contained in the alimentary canal[l]. But the same coloured stools are frequently observed when no mercury has been used. Like other mercurials, it increases the action of the secreting organs, and thus promotes the secretion of bile and of intestinal mucus; and we also presume it has a similar influence over the secretion of the pancreatic fluid. Neumann[m] states, that a man took two, then three, and subsequently four grains of calomel, daily, for the space of two months, without inducing salivation; but that three months afterwards he became affected with chronic vomiting, the consequence of a scirrhous pancreas, of which he died in four months. From the manner in which the case is related, it is clear the narrator attributed the disease of the pancreas to the use of mercury; whether justly or not, however, is impossible to determine.

The repeated and continued use of calomel, in small doses, is attended with the constitutional effects of mercurial preparations generally, before described.

In *large doses*, it has been regarded as an irritant poison; and, judging from the fatal effects ascribed to it by several writers, not without reason. Thus Hellweg[n] has reported a case in which a few grains of calomel, taken as a laxative, caused death; Vagnitius[o] saw fifteen grains prove fatal; and Ledelius[p], half an ounce. Fr. Hoffmann has also related two fatal cases[q].

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[j] To this statement exceptions are frequently observed. The following is an instance of the occasional violence of the action of calomel on children. The late Dr. Thomas Davies attended, with a medical friend of mine, a boy of four years of age, labouring under peritonitis. One grain of calomel was directed to be administered three times a day; and an aperient dose of calomel and jalap was given. On the fourth day its employment was stopped in consequence of its violent action. The cheeks were enormously swollen, the gums sloughed, necrosis of the alveolar process of the lower jaw on each side occurred, and portions of bone, with the teeth, came away. The child ultimately recovered in about twelve months; but the jaws cannot be separated, and the patient is now obliged to suck his food through the apertures left by the loss of bone.

[k] *Heilmittellehre*, 161.

[l] See also a paper *On the Effects of Calomel in producing Slimy Stools*, in the *Lond. Med. and Surg. Journ.*, April 1829, p. 344.

[m] Gräfe and Walther's *Journal*, Bd ii. H. 3. S. 432, quoted by G. A. Richter, *Ausführ. Arzneim.* v. 492.

"Whytt, Odier, Quin, Wilmer, Leib, and others," says Gölis[r], "gave calomel internally in far larger doses; as two, three, and more grains at a time; and continued its use many days in the same dose, without considering the many evacuations from the alimentary canal, or the violent colic pains; and they affirm that they have never remarked, from the effect of this agent given in these large doses, any bad consequences in the abdomen. Melancholy experience compels me to contradict them. Many times I saw, under those large and long-continued doses of calomel, the hydrocephalic symptoms suddenly vanish, and inflammation of the intestines arise, which terminated in death. Still oftener I observed this unfavourable accident from an incautious use of calomel in croup: viz. where all the frightful symptoms of this tracheal inflammation, which threatened suffocation, suddenly vanish, and enteritis develope itself, which passed rapidly into gangrene, and destroyed the patients."

In the *Times* newspaper of the 26th April, 1836, there is the report of a coroner's inquest on the body of a Mrs. Corbyn, who was destroyed by swallowing 20 grains of calomel, she having previously taken a moderate dose without its exciting what she considered a sufficient effect; and in the *India Journal of Medical Science*[s] is the case of a lad, aged 14, a native of Nepal, in whom six grains of calomel apparently produced inflammation and ulceration of the mouth, enormous swelling of the face, mercurial fetor of the breath, mortification, and death. There was no ptyalism.

In Pierer's *Annalen* for April 1827[t], is the case of a lady, who by mistake swallowed fourteen drachms of calomel at once. Acute pains in the abdomen came on, accompanied by frequent vomiting and purging. These symptoms were allayed by oleaginous demulcents; but on the second day salivation and ulceration of the mouth took place. In three weeks, however, she was perfectly recovered. Other violent effects are noticed by Wibmer, Gmelin, and others; but the instances adduced are sufficient to show that dangerous and even fatal effects may result from large doses, and therefore that Teichmeyer, Buchner, and others, are justified in ranking it among poisons.

Of late years, however, immense quantities of calomel have been administered medicinally, without giving rise to any symptoms of irritant poisoning,—nay, apparently with the opposite effect; for we have the concurrent testimony of many practitioners, that in yellow fever, cholera, and other dangerous diseases, calomel, in doses of a scruple and upwards, allays vomiting and purging; and on this account has been denominated a *sedative.* So that while in small doses (as from two to five grains) calomel is almost universally admitted to be an irritant to the bowels, it is asserted that larger ones are actually sedative. These statements appear to me to be almost inconsistent, and yet they are fair deductions from the experience of numerous intelligent practitioners. We must, therefore, endeavour to accumulate more facts, in order to illustrate the effects of calomel, and for the present confess we have very imperfect information respecting the nature of its action.

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[n] Wibmer, *op. cit.* iii. 71.
[o] *Ibid.*
[p] *Ibid.*
[q] *Ibid.*
[r] *Treatise on the Hydrocephalus Acutus*, by Dr. Gooch.
[s] *Lond. Med. Gaz.* xviii. 484.
[t] Quoted by Wibmer, *op. cit.* 72.

In a case published by Mr. Roberts[u], an ounce of calomel was swallowed by mistake, and retained on the stomach for two hours before the error was discovered. The only effects were slight nausea and faintness. Subsequently, emetics, lime-water, and purgatives, were administered; calomel was vomited up, and the day but one afterwards the patient was quite well. Neither salivation nor the slightest affection of the gums occurred.

The largest quantity of calomel given as a medicinal agent, at one dose, is, I believe, three drachms; "and it was followed," says Dr. Christison[v], from whom I quote the case, which occurred in America, "by only one copious evacuation, and that not till after the use of an injection." I have now before me reports of eighteen cases of spasmodic cholera, admitted in the year 1832 into the Cholera Hospital at Bethnal Green, in this metropolis, in which enormous quantities of calomel were employed by the house-surgeon, Mr. Charles Bennett (formerly one of my pupils), with very slight physiological effects. When a patient was brought into the hospital, two drachms of calomel were immediately given, and afterwards one drachm every one or two hours, until some effect was produced. In 17 out of 18 cases in which this plan was tried, the vomiting and purging diminished, and the patients recovered. Several of them took from 20 to 30 drachms without the subsequent ptyalism being at all excessive. In one case (a female, aged 36 years), 30⅓ drachms were administered within forty-eight hours; moderate ptyalism took place, and recovery. In the unsuccessful case which I have alluded to, 53 drachms of calomel were administered within forty-two hours, without the least sensible effect.

Dr. Griffin[w] also tells us, that in several cases of cholera he gave calomel hourly, "in scruple doses, to the amount of two or three drachms or upwards, without eventual salivation; and I recollect," he adds, "one instance in particular, in which I gave two drachms within an hour and a half with perfect success, and without affecting the system."

I do not pretend to reconcile these cases with those recorded by Hellweg, Vagnitius, Ledelius, Hoffman, and Gölis; in fact they appear to me irreconcileable. Dr. Christison, however, suggests that in those cases in which violent effects occurred, the calomel might contain corrosive sublimate.

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[u] *Lond. Med. Gaz.* xxii. 611.

[v] *Treatise on Poisons.*

[w] *Lond. Med. Gaz.* xviii. 880.

Mr. Annesley[x] accounts for the increased quantity of bile found in the stools after the use of calomel, by supposing that the gall-bladder sometimes becomes distended in consequence of the tenacity of the mucous secretion, by which the mouth of the *ductus communis choledochus* is closed; and that calomel acts chemically on the mucus, and detaches it. But the hypothesis is, I think, devoid of foundation.

Uses.—Calomel is very frequently used as an *alterative*, in glandular affections, chronic skin diseases, and disordered conditions of the digestive organs, more particularly in those cases connected with hepatic derangement. For this purpose it is usually taken in combination with other alteratives, as in the well-known Plummer's pill, which I shall presently notice.

It is very frequently employed as a *purgative*, though, on account of the uncertainty of its cathartic effects, it is seldom given alone; generally in combination with other drastic purgatives—such as jalap, scammony, compound extract of colocynth, &c. whose activity it very much promotes. We employ it for this purpose when we are desirous of making a powerful impression on the alimentary canal, and thereby of relieving affections of other organs, on the principle of counter-irritation. Thus in threatened apoplexy, in mental disorders[y], in dropsical affections, and in chronic diseases of the skin. In torpid conditions of the bowels, where it is necessary to use powerful cathartics to produce alvine evacuations, as in paralytic affections, it is advantageously combined with other purgatives. Sometimes we use it to promote the biliary secretion—as in jaundice and other affections of the liver, in chronic skin diseases, and in various disordered conditions of the alimentary canal not accompanied by inflammation. Moreover, in the various diseases of children requiring the use of purgatives, it is generally considered to be very useful; and its being devoid of taste is of course an advantage.

As a *sedative* it has been administered in yellow fever, spasmodic or malignant cholera, dysentery, and liver affections (vide p. 721). Dr. Griffin[z] asserts that calomel proved a most successful medicine in cholera, controlling or arresting its progress, in 84 cases out of 100, when administered while the pulse was perceptible at the wrist; but that, on the contrary, it proved detrimental when given in collapse. The practice was tested in 1448 cases. The dose was from one to two scruples every hour or half-hour.

As a *sialogogue*, it may be used in the cases in which I have already stated (p. 717) that mercurials generally are employed: with the view of preventing irritation of the alimentary canal, it is usually given in combination with opium, unless the existence of some affection of the nervous system contraindicates the use of narcotics. This combination is employed in peripneumonia, pleuritis, croup, laryngitis, hepatitis, enteritis, and other inflammatory diseases: in fever, syphilis, chronic visceral diseases, &c.

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[x] *Diseases of India.*
[y] *Lond. Med. Gaz.* iii. 692.
[z] *Ibid.* xxi. 880.

Calomel is frequently combined with other medicines, to increase their effects, as with squills, to produce *diuresis*, in dropsy; or with antimonials, to promote *diaphoresis*.

As an *anthelmintic* it is in frequent use, and forms one of the active ingredients of many of the nostrums sold for worms; though it does not appear to have any specific influence over parasitic animals.

The *local uses* of calomel are numerous. In diseases of the Schneiderian membrane, it is applied as a snuff. It is sometimes blown into the eye, to remove spots on the cornea. Dr. Fricke[a] has used it with great success in chronic cases of rheumatic, catarrhal, and scrofulous ophthalmia; but in two instances bad consequences resulted from its use. It is sometimes suspended in thick mucilage, and used as a gargle in venereal sore-throat, or injected into the urethra in blennorrhœa. Now and then it is used as a substitute for cinnabar in fumigation. As a local application, in the form of ointment, calomel is one of the most useful remedies we possess for the cure of several forms of chronic skin diseases.

Administration.—When used as an *alterative*, it is given in doses of from half a grain to a grain, frequently combined with oxysulphuret of antimony (as in *Plummer's Pill*) or antimonial powder, and repeated every, or every other night; a mild saline laxative being given the following morning. As a *purgative*, from two to five grains are given usually in combination with, or followed by, the use of other purgatives, especially jalap, senna, scammony, or colocynth. As a *sialogogue*, it is exhibited in doses of one to three or four grains, generally combined with opium or Dover's powder, twice or thrice a day. As a *sedative*, the dose is from a scruple to half a drachm, or more. Biett[b] has sometimes employed it as an *errhine*, in syphilitic eruptions. It is mixed with some inert powder, and given to the extent of from 8 to 20 grains daily. The use of acids with calomel frequently occasions griping. Calomel is most extensively employed in the diseases of children, and may be given to them in as large or proportionally larger doses than to adults. Salivation is a rare occurrence in them: indeed, Mr. Colles[c] asserts, that mercury *never* produces ptyalism, or swelling or ulceration of the gums, in infants; but this is an error.

1. PILULÆ HYDRARGYRI CHLORIDI COMPOSITÆ, L.; *Pilulæ Calomelanos compositæ*, E. D. *Compound Calomel Pills.* (Calomel; Oxysulphuret of Antimony, each ʒij.; Guaiacum, powdered, ℥ss.; Treacle ʒij. Rub the Calomel with the Oxysulphuret of Antimony, afterwards with the Guaiacum and the Treacle, until incorporated, *L.*—The *Edinburgh College* uses of Calomel, and Golden Sulphuret of Antimony, of each, *one part;* Guaiac, in fine powder, and Treacle, of each, *two parts;* the pill-mass is ordered to be divided into six-grain pills.—The *Dublin College* employs of Calomel, Brown Antimoniated Sulphur, of each, ʒj.; Guaiac, in powder, ʒij.; Treacle, as much as may be sufficient).—This compound is commonly known as *Plummer's Pill* (*Pilulæ Plummeri*) having been admitted into the Edinburgh pharmacopœia at his recommendation. These pills are frequently employed as alteratives in chronic skin diseases, in the papular and pustular forms of the venereal disease, in chronic liver affections, and in various disordered conditions of the digestive organs. The dose is from five to ten grains.

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[a] *Lond. Med. Gaz.* xxii. 397.

[b] *Ibid.* viii. 540.

[c] *Pract. Observ.* p. 281.

2. **PILULÆ CALOMELANOS ET OPII**, E.; *Calomel and Opium Pills.* (Calomel, *three parts;* Opium, *one part;* Conserve of Red Roses, *a sufficiency.* Beat them into a proper mass, which is to be divided into pills, each containing two grains of calomel). Each pill contains two-thirds of a grain of opium. It is a valuable compound in rheumatism and various other inflammatory diseases. Dose one or two pills. If ptyalism be required, one pill may be repeated three times daily.

3. **UNGUENTUM HYDRARGYRI CHLORIDI**; *Calomel Ointment.* (Calomel, ʒj.; Lard, ℥j.)—This is a most valuable application in porrigo favosa, impetigo, herpes, and the scaly diseases (psoriasis and lepra). Indeed, if I were required to name a local agent pre-eminently useful in skin diseases generally, I should fix on this. It is well deserving a place in the Pharmacopœia.

4. **PILULÆ CATHARTICÆ COMPOSITÆ**, Ph. of the United States; *Compound Cathartic Pills.* (Compound Extract of Colocynth, ℥ss.; Extract of Jalap, in powder; Calomel, of each, ʒiij.; Gamboge, in powder, ℈ij. M. Divide into 180 pills). This pill is intended to combine smallness of bulk with efficiency and comparative mildness of purgative action, and a peculiar tendency to the biliary organs[d]. Each pill contains one grain of calomel. Three pills are a full dose.

10. HYDRAR′GYRI BICHLO′RIDUM, *L.*—BICHLORIDE OF MERCURY.

(Sublimatus corrosivus, *E.*—Hydrargyri Murias corrosivus, *D.*)

History.—We have no account of the discovery of this preparation. Geber[e] described the method of preparing it; but it is supposed to have been known long anterior to him. Like calomel, it has had various synonymes, of which the principal are the following:—*Chloride, Hydrochlorate, Muriate* or *Oxymuriate of Mercury* (*Hydrargyri Chloridum, Hydrochloras, Murias* vel *Oxymurias*), *Corrosive Sublimate, Corrosive Muriate of Mercury* (*Hydrargyri Murias corrosivus*), and *Acidum Chloro-hydrargyricum*).

Preparation.—All the British Colleges give directions for the preparation of this salt.

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[d] *United States Dispensatory.*

[e] *Inv. of Ver.* viii. 252.

The *London College* orders of Mercury, lbij.; Sulphuric Acid, lbiij.; Chloride of Sodium, lbjss. Boil down the Mercury with the Sulphuric Acid in a proper vessel, until the Bipersulphate of Mercury remains dry; rub this when it is cold with the Chloride of Sodium in an earthen mortar; then sublime with a heat gradually raised.

The *Edinburgh College* directs of Mercury, ℥iv.; Sulphuric Acid (commercial) f℥ij. and fʒiij.; Pure Nitric Acid, f℥ss.; Muriate of Soda, ℥iij. Mix the acids; add the mercury; dissolve it with the aid of a moderate heat; and then raise the heat so as to obtain a dry salt. Triturate this thoroughly with the muriate of soda; and sublime in a proper apparatus.

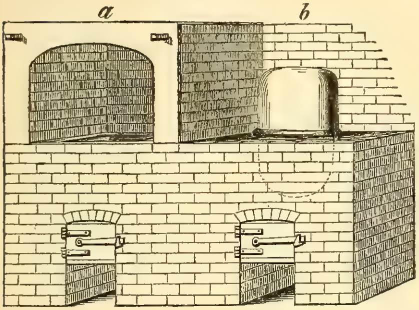
The *Dublin College* gives a separate formula for the preparation of the bipersulphate of mercury (*Hydrargyri Persulphas*, D.) It is as follows:—

Take of purified Mercury, Sulphuric Acid, of each, *six parts.* Nitric Acid, *one part.* Let them be exposed to heat in a glass vessel, and let the fire be increased until the thoroughly dried residue shall have become white. From this salt corrosive sublimate is directed to be thus procured.

Take of Persulphate of Mercury, *five parts;* Dried Muriate of Soda, *two parts.* Let them be well rubbed together in an earthen-ware mortar, that a most subtile powder may be formed; then, with a heat gradually raised, let the Corrosive Muriate of Mercury be sublimed into a proper receiver.

Bipersulphate of mercury is usually prepared by submitting the sulphuric acid and mercury to heat in an iron pot, set in brickwork, over a proper fire, and under a hood or chimney to carry off the vapour of sulphurous acid (fig. 121 *a*). The mixture of bipersulphate and common salt is subjected to sublimation in an earthen alembic placed in sand contained in an iron pot; or in an iron pot lined with clay, and covered by an inverted earthen pan (as in fig. 121 *b*). The same pot, with a different head, may be used in the preparation of calomel.

Fig 121.



Furnaces for the preparation of Corrosive Sublimate.

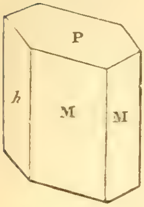
a. Furnace for the preparation of the bipersulphate of mercury. When the operation is going on, an iron plate is suspended in front of the hood to prevent the escape of vapour.
b. Furnace for the sublimation of the bichloride.

The nature of the changes which occur in the manufacture of bipersulphate of mercury have been already explained (p. 737). When this salt is sublimed with chloride of sodium, double decomposition takes place, and we obtain bichloride of mercury and sulphate of soda.

MATERIALS.	COMPOSITION.		PRODUCTS.
2 eq. Chloride Sod^{m} 120	2 *eq. Chlorine* 72		1 eq. Bichl^{de} Merc^{y} 274
	2 *eq. Sodium* 48	2 eq. Soda 64	
1 eq. Bipersulphate Mercury 298	2 *eq. Oxygen* 16		
	1 *eq. Mercury* 202		
	2 *eq. Sulphur^{c} Acid* 80		2 eq. Sulphate Soda 144
418	418		418

Bichloride of mercury may also be procured by the direct union of its constituents, chlorine and mercury. It may likewise be prepared by dissolving the red or binoxide of mercury in hydrochloric acid.

FIG. 122.



Crystal of Bichloride of Mercury.

PROPERTIES.—As usually met with in commerce, bichloride of mercury is a semi-transparent crystalline mass, in which perfect crystals are rarely found. Occasionally, however, they are obtained either by slow sublimation, or from a solution of the salt. Their form is the right rhombic prism. Their sp. gr. is about 5·2 (5·14 to 5·42, Liebig). The taste of this salt is acrid, coppery, and persistent. When heated it fuses, boils, and volatilizes: the vapour is very acrid. It is soluble in about three times its weight of boiling, and in about eighteen or twenty times its weight of cold water: the acids (especially hydrochloric) and the alkaline chlorides increase its solubility. It is soluble in seven parts of cold or three and a half parts of boiling alcohol. Ether dissolves it more readily than alcohol, and will even separate it from its watery solution; and hence is sometimes employed to remove it from organic mixtures.

An aqueous solution of bichloride of mercury readily undergoes decomposition, especially when exposed to solar light; calomel is precipitated, and hydrochloric acid set free. This change is facilitated by the presence of organic substances,—as gum, extractive, or oil; whereas it is checked by the presence of alkaline chlorides.

Albumen forms a white precipitate with an aqueous solution of bichloride of mercury. This precipitate is slightly soluble in water, and consists, according to Lassaigne[f], of albumen, 93·45, and bichloride of mercury, 6·55; so that it is a *hydrargyro-chloride of albumen.* Fibrin forms a similar white compound with corrosive sublimate. When albuminous and fibrinous textures are immersed in a solution of this salt, combination takes place, the tissue contracts, increases in density, becomes whiter, and does not putrefy. Hence it is employed by the anatomist for hardening and preserving certain parts of the body—as the brain.

A solution of bichloride of mercury possesses some of the characters of an acid. Thus its solution reddens litmus, and it unites with the chlor-bases (as chloride of sodium), forming the double salts called *hydrargyro-chlorides.* Litmus, which has been reddened by a solution of bichloride of mercury, has its blue colour restored by chloride of sodium.

Characteristics.—Bichloride of mercury is known to be a *mercurial* compound by the following characters:—

α. *Heated* in a tube by a spirit lamp, with caustic potash, an alkaline chloride is formed, oxygen gas is evolved, and metallic mercury is sublimed and condensed in the form of globules on the sides of the tube.

β. *Lime-water* causes a lemon-yellow precipitate (*hydrated binoxide of mercury*). If the bichloride be in excess, the precipitate is brick-red (*oxychloride of mercury*), and the *hydrargyro-chloride of calcium* is found in solution.

γ. *Caustic ammonia*, added to a solution of bichloride, causes hydrochlorate of ammonia to be formed in solution, while a white powder (*hydrargyri ammonio-chloridum)* is thrown down.

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[f] *Journ. de Chim. Méd.* iii. 2de Serie, 161.

δ. The *alkaline carbonates* throw down a brick-red precipitate: the bicarbonates either none or a white one.

ε. *Iodide of potassium* occasions a scarlet precipitate (*biniodide of mercury*); but the precipitate frequently appears at first of a yellow colour, though it quickly becomes scarlet. Dumas[f] thinks these yellow and red states of the biniodide depend on some isomeric phenomena requiring farther examination. If an excess of iodide of potassium be employed, the red precipitate disappears, owing to the formation of a soluble double salt, in which the biniodide of mercury acts the part of an acid, and the iodide of potassium that of a base. This double salt is the *hydrargyro-iodide of potassium.* Bichloride of mercury and the biniodide of mercury also form a double salt: hence, if a great excess of the former salt be employed, the red precipitate disappears, owing to the formation of a soluble double salt.

ζ. *Protochloride of tin* occasions, with bichloride of mercury, a white precipitate (*calomel*), while perchloride of tin remains in solution. Very shortly this protochloride of mercury is converted into reguline mercury, which falls down in a finely divided state as a greyish powder.

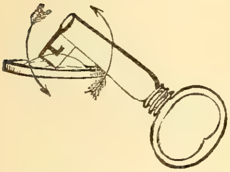
η. *Hydrosulphuric acid* in excess, passed through a solution of bichloride of mercury, occasions a black precipitate (*bisulphuret of mercury*), while a solution of hydrochloric acid is formed. If the hydrosulphuric acid be not in excess, a white precipitate (*chloro-sulphuret of mercury*) is obtained, composed of two atoms bisulphuret of mercury and one of the bichloride.

ϑ. *Ferrocyanide of potassium* causes a white precipitate (*ferrocyanide of mercury*).

ι. *Albumen* is another test for corrosive sublimate, though not one of much value, since it will produce the same white precipitates with many other substances.

κ. *Galvanism.*—Drop the suspected solution on a piece of gold, as a sovereign, and apply a key, so that it may touch, simultaneously, the gold and the solution; an electric current is immediately produced, the bichloride is decomposed, the mercury attaches itself to the negative electrode (or pole), namely the gold, while the chlorine unites with the iron of the positive electrode (or pole) to form chloride of iron. The relative position of the gold, the key, and the solution, will be evident from the fig. 123, and the arrows point out the direction of the electric current. The silver stain left on the gold is readily removed by heat. In Dr. Christison's work will be found other methods of applying galvanism; but the one just mentioned is perhaps the most useful, since it can always be readily made use of; whereas a more complicated apparatus is found in the hands of a few persons only. Thus it might be applied at a moment's notice to detect corrosive sublimate in the matters vomited by a patient.

FIG. 123.



The relative delicacy of some of these tests is thus stated by Devergie[g]:—

		Degree of Dilution.
Ferrocyanide of potassium	stops at ..	1,500
Lime water	,, ..	4,000
Potash or its carbonate	,, ..	7,000
Iodide of potassium	,, ..	8,000
Ammonia	,, ..	36,000
Hydrosulphuric acid, or hydrosulphate of ammonia	,, ..	60,000
Protochloride of tin, or galvanic pile	,, ..	80,000

The preceding tests have not determined the nature of corrosive sublimate, further than that it is a permercurial salt. To prove that it is a chloride, the simplest method of proceeding is to add to the suspected solution, lime-water, or carbonate of soda; then filter, acidify with diluted nitric acid, and test the clear liquid with *nitrate of silver*, which causes a white precipitate (*chloride of silver*), insoluble in nitric acid, but soluble in ammonia. If nitrate of silver be added to a solution of bichloride of mercury, we obtain a white precipitate of chloride of silver, but which may be mixed with calomel; and it is to avoid the production of the latter substance that I prefer the method of testing just mentioned.

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[f] *Traité de Chimie*, iii. 619.
[g] *Méd. Lég.* ii. 676.

COMPOSITION.—The composition of this salt is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Turner.*
Mercury	1	202	73·72	73·53
Chlorine	2	72	26·27	26·47
Bichloride of Mercury	1	274	99·99	100·00

PURITY.—Pure bichloride should be white, dry, totally vapourized by heat, and completely soluble in water, alcohol, or ether.

It liquefies by heat, and sublimes. It is totally soluble in water and sulphuric ether. Whatever is thrown down from water, either by solution of potash or lime-water, is of a reddish colour: or, if a sufficient quantity be added, it is yellow. This yellow substance by heat emits oxygen, and runs into globules of mercury. *Ph. Lond.*

It sublimes entirely by heat; and its powder is entirely and easily soluble in sulphuric ether. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The effects of solutions of bichloride of mercury on plants have been examined by Seguin, and subsequently by Marcet and Macaire[i], and from their experiments it appears, that when growing plants are immersed in a solution of this salt, part of the poison is absorbed, a change of colour takes place in the leaves and stems, and death is produced. Bichloride of mercury is equally poisonous to cryptogamic plants. Hence vegetable tissues soaked in a solution of it are no longer adapted for the developement of the *Merulius lachrymans*, and of other fungi known under the name of the *Dry-Rot*. This, in fact, is the principle adopted by Mr. Kyan[j] for the preservation of timber, and which is now practised by the *Anti Dry-Rot Company*[k].

β. *On Animals generally.*—The effects of corrosive sublimate on animals have been examined by Ettmuller, Wepfer, Sprœgel, Sir Benjamin Brodie[l], Campbell, Lavort, Smith, Gaspard, Orfila[m], Schubarth, and Bostock. An abstract of these will be found in the works of Wibmer[n], and Christison[o]. Dogs, cats, horses, rabbits, and frogs, are the animals on which the experiments have been tried, and on which sublimate has been found to exercise a poisonous operation, and the same kind of effect is presumed, from analogy, to be produced on all other animals. The results of these experiments have been so briefly yet clearly stated by Dr. Christison, that I cannot do better than quote his words:—"Corrosive sublimate causes, when swallowed, corrosion of the stomach; and in whatever way it obtains entrance into the body, irritation of that organ and of the rectum, inflammation of the lungs, depressed action, and perhaps also inflammation of the heart, oppression of the functions of the brain, and inflammation of the salivary glands." I may add, that mercurial fœtor and salivation have been observed in horses, dogs, and rabbits.

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[i] De Candolle, *Phys. Vég.* 1332.

[j] *Lond. Med. Gaz.* xvi. 630.—*Vide* also Dr. Dickson's *Lecture on Dry Rot.* Lond. 1837.

[k] See Keraudren, *Des Proprietés du Sublimé Corrosif pour la conservation du bois, et des effets de cette préparation sur la santé des marins*, in the *Mém. Royale Acad. de Méd.* t v. p. 41. Paris, 1836. I have seen wood which had been prepared by Kyan's process, and which became black on the application of hydrosulphuret of ammonia (shewing the presence of mercury), covered with cottony fungi which grew from it. Sir John Barrow in his *Life of Lord Anson* says, wood thus prepared is attacked by the Teredo.

[l] *Phil. Trans.* for 1812.

[m] *Toxicol. Gén.*

[n] *Wirk. d. Arzn. u. Gifte.*

[o] *Treat. on Poisons.*

λ. *On Man.*—α α. *In small or therapeutic doses,* as from one-eighth to one-fourth of a grain, it frequently exerts a beneficial effect on diseases (syphilitic eruptions, for example), without producing any obvious alteration in the actions of the different organs. Occasionally, especially when the stomach and bowels are in an irritable condition, it gives rise to a sensation of warmth in the epigastrium, and causes nausea, griping, and purging. In such cases it is best to diminish the dose, and conjoin opium. By repetition we frequently observe that the pulse becomes somewhat excited, and if the skin be kept warm, perspiration is oftentimes brought on; at other times the quantity of urine is increased. Continued use of it causes salivation: but it is said, that corrosive sublimate has less tendency to occasion this effect than other preparations of mercury. Maximilian Locher[p], who, from the year 1754 to 1762, cured 4,880 patients affected with the venereal disease, at St. Mark's Hospital, Vienna, by the exhibition of this remedy, says, that no person died, or experienced the least painful or dangerous symptoms, in consequence of its use. He was, however, exceedingly cautious and careful in its employment, and always stopped its administration on the first appearance of salivation. Van Swieten says, "I am convinced, from repeated experience, that the menstrual evacuation is not disturbed by the use of this remedy."

β β. Chronic poisoning. In somewhat larger doses, or by the long-continued use of the before-mentioned small doses, gastro-enteritis and all the usual constitutional effects of mercury are brought on. Thus heat and griping pain in the alimentary canal (particularly in the stomach and rectum), loss of appetite, nausea, vomiting, purging, and disordered digestion, are the gastro-enteritic symptoms. The pulmonary organs also not unfrequently become affected; the patient complains of dry cough, pain in the chest, disordered respiration, and bloody expectoration. Coupling these symptoms with the effects said to be produced on the lungs of animals by the use of corrosive sublimate, we have an important caution not to administer it to patients affected with pulmonary disorders,—a caution, indeed, which Van Swieten gives; "for those," says he, "who have a husky dry breast, are troubled with a cough, whose nervous system is excessively irritable, and are subject to a hemorrhage, bear not this remedy without detriment."

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[p] Van Swieten's *Commentaries upon Boerhaave's Aphorisms,* xvii. 294.

γγ. *Acute poisoning.*—In *very large doses* corrosive sublimate acts as a caustic poison, in virtue of its affinity for albumen, fibrin, and other constituents of the tissues. I shall follow Dr. Christison, and admit two varieties of poisoning by it; in one of which "the sole or leading symptoms are those of violent irritation of the alimentary canal. In another variety the symptoms are at first the same as in the former, but subsequently become conjoined with salivation and inflammation of the mouth, or some of the other disorders incident to mercurial erethysm, as it is called."

First variety: Gastro-enteritis.—In this variety the symptoms are analogous to those of other corrosive poisons: namely, violent burning pain in the mouth, throat, œsophagus, and stomach; difficulty of deglutition; sense of suffocation; nausea; violent vomiting (increased by every thing taken into the stomach) of mucous, bilious, or sanguineous matters. The pain soon extends from the stomach over the whole abdomen, which becomes acutely sensible to the slightest impression; violent purging, often of blood; inexpressible anxiety; flushed countenance; restlessness; pulse quick, small, and contracted; cold sweats; burning thirst; short and laborious respiration; urine frequently suppressed; and, lastly, various indications of a disordered condition of the nervous system, such as a tendency to stupor, or even actual coma; convulsive movements of the muscle of the face and extremities: sometimes diminished sensibility of one of the limbs, or of the whole body; or even paraplegia. Occasionally death appears to result from the powerful effect produced on the nervous system, or from exhaustion, or from mortification of the bowels.

Dr. Christison points out the following characters as serving to distinguish poisoning by bichloride of mercury from that by arsenious acid:—

1. The symptoms begin much sooner.
2. The taste is much more unequivocal and strong.
3. The acridity and irritation in the gullet is much greater.
4. The countenance is flushed, and even swollen; whereas, in poisoning by arsenic, it is usually contracted and ghastly.
5. Blood is more frequently discharged by vomiting and purging.
6. Irritation of the urinary passages is more frequent.
7. Nervous affections are more apt to come on during the first inflammatory stage.
8. The effects are more curable than those of arsenic.
9. Deviations in the symptoms are more rare.

Second variety: Gastro-enteritis, accompanied with or followed by mercurial erethysm.—I here use the term erethysm in the sense in which it is employed by Dr. Christison,—namely, to indicate all the secondary effects of mercury. In this variety, the symptoms first observed are those mentioned for the last variety, but they are followed, soon er orlater, by those of inflammation of the salivary glands, and of the mouth and its neighbouring parts; profuse salivation, ulceration of the mouth, great fœtor of the breath, and other symptoms of this kind, already described.

USES.—*Internally* it has been employed as a sialogogue, alterative, and diaphoretic.

The celebrated Baron Van Swieten[q] may be regarded as the principal introducer of corrosive sublimate into practice as a remedy for *venereal diseases*[r]. He seems to have been led to its employment from a suspicion that salivation was not requisite for curing this class of diseases; and hence he was desirous of obtaining some mercurial

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[q] *Op. cit.*

[r] See also several papers on the use of bichloride in syphilis, in the *Medical Observations and Inquiries*, vols. i. and ii.

"that could be diluted at will, and so tried in a very small dose." Now corrosive sublimate possessed these properties, and hence he commenced his experiments with it, and, meeting with great success, recommended it to Maximillian Locher, whose results I have already stated[s]. The balance of evidence is decidedly favourable to the employment of this medicine as an internal remedy for venereal diseases. By its partizans it has been asserted to be a safe and efficacious mercurial, to remove venereal symptoms in a very short space of time, and without causing salivation, merely by exciting diaphoresis. Its opponents[t] state, on the other hand, that other mercurials are quite as effectual and speedy; that the cure by corrosive sublimate is not permanent; and, lastly, that its corrosive and irritant properties render its employment objectionable. One of the latest advocates for its use is Dzondi[u], of Halle, who states, that the best mode of using bichloride of mercury is in the form of pills made with crumb of bread; and he gives the following formula for their preparation:—℞ Hydr. Sublim. Corros. gr. xij., solve in Aq. Distill. q. s., adde Micæ Panis Albi, Sacchari Albi, āā. q. s. ut ft. pilulæ numero CCXL. Of these pills (each of which contains one-twentieth of a grain of corrosive sublimate), four are to be administered daily, and increased until thirty (containing one grain and a half) are taken at a dose. The best time of exhibiting them is after dinner. In irritable subjects, and painful affections, a few drops of the tincture of opium may be taken with each dose. During the time the patient is under their influence he should adopt a sudorific regimen (as is also recommended by Van Swieten), and take decoction of sarsaparilla.

In *acute diseases* few have ventured to employ bichloride of mercury: however, Schwartz gave it in hepatitis after the fever and pain had subsided; Sauter employed it in an epidemic scarlet fever; and Berends[v] administered it in asthenic malignant fevers. I have already noticed (p. 718) Mr. Lempriere's proposal to use it in fever as a sialogogue.

In various *chronic diseases* it has been given as an *alterative* and *diaphoretic*, with occasional success. Thus in rheumatism, diseases of the bones, periodical pains, skin diseases, scrofulous affections, disorders of the nervous system, &c. In such it should be associated with diaphoretics (as antimony, sarsaparilla, &c.), warm clothing, &c. Not unfrequently opiates should be combined with it.

As an *external* remedy it has been employed as a *caustic* in substance (either alone or combined with arsenic) to cancerous ulcers, to parts bitten by rabid animals, to chancres, &c.: used in this way, however, it is mostly objectionable. In onychia maligna it is used with great advantage, mixed with an equal weight of sulphate of zinc, and sprinkled thickly upon the surface of the ulcer, which is then to be covered with a pledget of lint saturated with tincture of myrrh[w]. A *solution* has been employed for various purposes: thus by Baumé, as already mentioned (p. 716), for pediluvia, to produce salivation; as a lotion in chronic skin disease (as lepra, psoriasis, scabies, rosacea, &c.); as a wash to ulcers, particularly those of a venereal nature; as an injection in discharges from the urinary organs; as a collyrium in chronic diseases of the eye, especially those of a venereal nature; and as a gargle in ulcers of the tonsils. A solution is sometimes used as a preventive for the venereal disease.

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[s] For further historical details respecting its use, *vide* Pearson's *Observations on the Effects of various Articles of the Mat. Med.* p. 99, et seq.

[t] *Vide* Pearson, *op. cit.*

[u] *Neue zuverläss. Heilart. d. Lusts. in allen ihren Formen*, &c. 1826, in Richter, *Ausf. Arzn.* Bd. v. S. 596.

[v] Richter, *Ausführ. Arzneim.* v. 581.

ADMINISTRATION.—It may be used internally, in substance or solution. The dose of it in substance is from one-sixteenth to one-eighth of a grain. Some advise it to be given to the extent of one-fourth of a grain; but in this dose it is very apt to gripe and purge. Dzondi's formula, already given, may be employed when we wish to administer it in substance.

In solution it may be exhibited dissolved in water (vide *liquor hydrargyri bichloridi*), alcohol, or ether.

For *external use*, a watery solution may be employed, containing from half a grain to two or three grains, dissolved in one ounce of water.

ANTIDOTES.—Several substances which decompose corrosive sublimate have been employed as antidotes. These are, *Albumen*, *Gluten of Wheat* (as contained in wheaten flour), *Milk*, *Iron Filings*, *and Meconic Acid.*

I have already alluded to the decomposition of corrosive sublimate by *Albumen.* The compound which results from their mutual action appears to be inert, or nearly so. In Dr. Christison's *Treatise on Poisons* will be found several cases noticed, in which albumen has been most effectual: one of the most interesting of which is that of Baron Thenard, the celebrated chemist, who inadvertently swallowed a concentrated solution of corrosive sublimate, but by the immediate use of whites of eggs suffered no material harm. Peschier states, that one egg is required for every four grains of the poison. *Gluten of wheat* has been recommended by Taddei, and may be employed when albumen is not procurable. Wheaten flour (which contains gluten) will probably answer as well as the pure gluten. *Milk*, in the absence of albumen or flour, may be used. *Iron filings* are stated to be useful, by reducing the corrosive sublimate to the metallic state. *Meconic acid* is also said to be an antidote, by forming an insoluble meconate of mercury. But a knowledge of the fact is of little practical value, since the acid is not generally procurable; and tincture of opium, which contains it, cannot be safely used in sufficient quantity; for Dr. Christison finds that five grains of corrosive sublimate require an infusion of 33 grains of opium to precipitate the whole of the mercury.

The other parts of the treatment for acute poisoning by corrosive sublimate are the same as for other irritant poisons, and consist of the usual antiphlogistic system—the use of warm baths, opiates, &c.

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[w] *United States Dispensatory.*

LIQUOR HYDRARGYRI BICHLORIDI, L. *Solution of Bichloride of Mercury.* (Take of Bichloride of Mercury; Hydrochlorate of Ammonia, each, grs. x.; Distilled Water, Oj. Dissolve the bichloride of mercury and hydrochlorate of ammonia together in water.) Hydrochlorate of ammonia is used to increase the solvent power of the water. Each fluidounce contains half a grain of corrosive sublimate. The dose of this solution is from half a fluidrachm to two or three fluidrachms, taken in some bland liquid, as linseed tea.

11. HYDRAR'GYRI AMMO'NIO-CHLO'RIDUM, *L.*—AMMONIO-CHLORIDE OF MERCURY.

(Hydrargyrum præcipitatum album, *E.*—Hydrargyri submurias ammoniatum, *D.*)

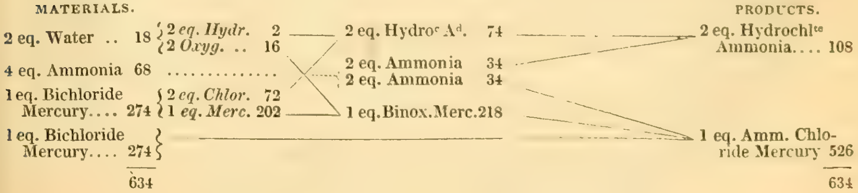
History.—This compound was discovered by Raymond Lully, in the thirteenth century. Lemery pointed out two modes of procuring it, and hence it is sometimes termed *Lemery's White Precipitate*, to distinguish it from precipitated calomel, also called on the Continent white precipitate. It has had various other appellations, as *Cosmetic Mercury* (*Mercurius Cosmeticus*), *White Precipitated Mercury;* and, according to the view taken of its composition, it has been called *Muriate of Ammonia and Mercury*, *Ammoniated Submuriate of Mercury*, *Ammoniated Mercury*, *Ammoniacal Oxychloruret of Mercury*, and *Chloramide* or *Chloro-amidide of Mercury.* Its most familiar name is *White Precipitate.*

Preparation.—All the British Colleges give formulæ for the preparation of this salt.

The *London College* orders of Bichloride of Mercury, ℥vj.; Distilled Water, Ovj.; Solution of Ammonia, f℥viij. Dissolve the Bichloride of Mercury, with the application of heat, in the Water. To this when it is cold add the Solution of Ammonia, frequently stirring. Wash the powder thrown down until it is free from taste; lastly, dry it.

The *Edinburgh College* directs of Corrosive Sublimate, ℥vj.; Distilled Water, Ovj.; Aqua Ammoniæ, f℥viij. Dissolve the Corrosive Sublimate with the aid of heat in the Distilled Water; and when the solution is cold add the Aqua Ammoniæ; stir the whole well; collect the powder on a calico filter, and wash it thoroughly with cold water.

The explanation of the changes which occur in the above processes will vary according to the view taken of the constitution of white precipitate. If, with Mr. Phillips, we regard it as a compound of bichloride and binoxide of mercury with ammonia, its formation may be thus accounted for: 4 eqs. of ammonia, 2 eqs. of water, and 2 eqs. of bichloride of mercury, react on each other and yield 2 eqs. of sal ammoniac (hydrochlorate of ammonia), and 1 eq. of white precipitate.



Dr. Kane[v], however, states that white precipitate contains neither ammonia nor oxygen, but, instead of these, the elements of amidogen ($N\,H^2$). He, therefore, regards it as a compound of bichloride and binamidide of mercury ($Hg\,Chl^2 + Hg\,Ad^2$) or as a chloro-amidide of mercury. It is formed by the mutual reaction of two equivalents of bichloride of mercury ($2\,Hg\,Chl^2$) and four equivalents of ammonia (4 eqs. *amidide of hydrogen* $= 4\,HAd$): the products being one equivalent of white precipitate ($Hg\,Chl^2 + Hg\,Ad^2$) and two equivalents of sal ammoniac (2 eqs. of *chloro-amidide of hydrogen* $= 2\,(H\,Chl + H\,Ad)$).

The *Dublin College* gives the following directions for its preparation:—Add to the liquor poured off from precipitated Calomel as much water of Caustic Ammonia as may be sufficient completely to throw down the metallic salt; which is to be washed with cold water and dried on bibulous paper.

Owing to the presence of some pernitrate of mercury in the protonitrate from which calomel is precipitated on the addition of chloride of sodium (see p. 739), there is some bichloride of mercury formed in the liquor. This is, therefore, directed to be used by the Dublin College in the preparation of white precipitate.

PROPERTIES.—It occurs in commerce in masses or in powder. It is white, inodorous, has a taste at first earthy, afterwards metallic. It is decomposed and dissipated by heat, giving out ammonia, nitrogen, calomel, and water. It is insoluble in alcohol. By boiling in water we obtain a solution of hydrochlorate of ammonia, and a yellow powder (*white precipitated mercury and binoxide of mercury*, KANE). It is soluble in sulphuric, nitric, and hydrochloric acids.

Characteristics.—When heated with caustic potash, it gives out ammonia, and forms a yellow powder (*white precipitated mercury and binoxide of mercury*, KANE). The solution contains chloride of potassium, and with nitrate of silver yields a white precipitate (*chloride of silver*), insoluble in nitric acid, but soluble in ammonia. Caustic ammonia does not alter white precipitate. By this it may, therefore, be distinguished from calomel, which yields a grey powder (*protoxide of mercury*) on the addition of ammonia. Protochloride of tin decomposes white precipitated mercury, and separates metallic mercury. To these characters must be added the effect of heat, water, and acids, as above mentioned.

COMPOSITION.—The analyses of Mr. Hennel[w] and Mitscherlich[x], agree in showing the elements of white precipitate to be those of binoxide of mercury and hydrochlorate of ammonia, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Hennel.*	*Mitscherlich.*
Binoxide of Mercury	1	218	80·14	80	82·2
Hydrochloric Acid	1	37	13·60	20	10·7
Ammonia	1	17	6·25		7·1
White Precipitate	1	272	99·99	100	100·0

This composition is adopted by Berzelius. But in explaining the theory of the formation of the white precipitate, I have assumed, with Mr. Phillips[y], a somewhat different view of the subject. Two equivalents of the white precipitate of Mr. Hennel, minus two equivalents of water, are equal to one equivalent of the same compound, according to Mr. Phillips.

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[v] *Trans. of the Royal Irish Academy*, vii. 423.

[w] *Quarterly Journal of Science*, xviii. 297.

[x] *Ann. Chim.* xxxv. 428.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Bichloride of Mercury	1	274	52·09
Binoxide of Mercury	1	218	41·44
Ammonia	2	34	6·46
White Precipitate (Phillips)	1	526	99·99

If two more equivalents of water be abstracted, we have the composition of white precipitate, according to Dr. Kane.

	Atoms.	*Eq. Wt.*	*Per Cent.*
Bichloride of Mercury	1	274	53·93
Binamide of Mercury	1	234	46·06
Chloro-amidide of Mercury	1	508	99·99

PURITY.—This compound is largely adulterated with sulphate of lime. I have one sample containing one-third of its weight of this substance. Carbonate of lime and of lead are sometimes employed to adulterate white precipitate. Pure white precipitate, thrown on a red-hot shovel, is dissipated without any residuum: whereas the above impurities remain. The carbonates are recognised by the effervescence on the addition of hydrochloric acid. Sulphate of lime may be detected by boiling the suspected substance in distilled water, and applying the tests for sulphates and calcareous salts, as before directed (pp. 469 and 578).

Totally evaporated by heat. When digested with acetic acid, iodide of potassium throws down nothing either yellow or blue. The powder rubbed with lime-water does not become black. It is totally dissolved by hydrochloric acid without effervescence. When heated with solution of potash it becomes yellow, and emits ammonia. *Ph. Lond.*

The iodide of potassium is employed to detect lead or starch in the acetic solution. If lime-water occasion a black precipitate, it indicates the presence of a protosalt of mercury.

PHYSIOLOGICAL EFFECTS.—Its action on the body is very imperfectly known, no modern experiments having been made with it. It is usually considered to be highly poisonous, and somewhat similar in its operation to bichloride of mercury. Palmarius and Naboth[z] have reported fatal cases of its use[a].

USES.—It is employed as an external agent only; commonly in the form of an ointment. It is an efficacious application in various skin diseases—as porrigo, impetigo, herpes, and even scabies; also in ophthalmia tarsi. Among the lower classes it is commonly used to destroy pediculi.

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[y] *Translation of the London Pharmacopœia.*

[z] Wibmer, *Wirk. d. Arzn.* iii. 64.

[a] Vide also Gmelin, *App. Medicam.* ii. 166.

UNGUENTUM HYDRARGYRI AMMONIO-CHLORIDI, L.; *Unguentum Præcipitati albi*, E.; *Unguentum Hydrargyri Submuriatis Ammoniati*, D.; *Ointment of White Precipitate.* (White Precipitate, ʒj.; Lard, ℥iss. Mix.) Stimulant, alterative, and detergent. Used in various skin diseases as above-mentioned.

HYDRAR′GYRI IO′DIDUM, *L.*—IODIDE OF MERCURY.

History. — This compound is commonly called *Protiodide of Mercury*, to distinguish it from other iodides of this metal.

Preparation.—There are several methods of preparing this compound.

The *London College* orders of Mercury, ℥j.; Iodine, ʒv.; Alcohol, *as much as may be sufficient.* Rub the Mercury and Iodine together, adding the alcohol gradually, until globules are no longer visible. Dry the powder immediately, with a gentle heat, without the access of light, and keep in a well-stoppered vessel.

In this process the mercury and iodine enter into combination. The alcohol facilitates the union by dissolving a portion of iodine and forming with the remainder a pasty mass. Some biniodide is usually first formed, and is afterwards transformed into the protiodide by uniting with mercury.

This process succeeds well when small quantities of iodide are to be prepared; but it is scarcely applicable to the preparation of large quantities, owing to the great heat which is evolved, by which iodine is volatilized and some biniodide formed. Soubeiran[b] says that the mass sometimes inflames, and escapes from the mortar with a kind of explosion. To avoid these inconveniences small quantities only (7 or 8 ounces, for example) should be prepared at one time, and the quantity of alcohol should be augmented.

Another mode of preparing protiodide of mercury is by the addition of solution of iodide of potassium to a solution of protonitrate of mercury, acidified with a very small quantity of nitric acid, as long as a greenish precipitate is produced. There are, however, some difficulties in this mode of proceeding. A subnitrate of mercury is apt to be precipitated with the protiodide, and if, to avoid this, we use excess of nitric acid, this decomposes the iodide of potassium and sets iodine free, which combines with the protiodide to form the biniodide. If the solution of protonitrate be added to that of the iodide of potassium, metallic mercury and biniodide are apt to be formed: the latter is at first dissolved, but is afterwards deposited with the protiodide.

Properties.—It is a greenish-yellow powder, whose sp. gr. is 7·75. It is insoluble in water, alcohol, or an aqueous solution of chloride of sodium; but is soluble in ether, and slightly so in an aqueous solution of iodide of potassium. When heated quickly, it fuses and sublimes in red crystals, which become yellow by cooling.

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[b] *Nouveau Traité de Pharmacie*, t. ii. p. 513, 2^{nde} éd.

Solar light decomposes it, and changes its colour. Heated with potash, it yields iodide of potassium and reguline mercury.

When recently prepared it is yellowish, and when heat is cautiously applied it sublimes in red crystals, which afterwards become yellow, and then by access of light they blacken. It is not soluble in chloride of sodium. *Ph. Lond.*

COMPOSITION.—It consists of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Mercury	1	202	61·58
Iodine	1	126	38·41
Iodide of Mercury	1	328	99·99

PHYSIOLOGICAL EFFECTS.—It is a powerfully irritant poison. A scruple killed a rabbit within twenty-four hours, and a drachm destroyed a pointer dog in five days[d].

In small but repeated doses, it appears to exercise a specific influence over the lymphatic and glandular system. Two grains taken daily caused salivation in two instances[e].

USES.—It has been used in syphilis and scrofula, especially when they occur in the same individual. Lugol[f] employed an ointment of it in those forms of external scrofulous disease which resemble syphilis. Ricord[g] gave it internally with good effect in *syphilis infantum*. Biett[h] has successfully employed it in syphilitic ulceration and venereal eruptions.

ADMINISTRATION.—The dose of it for adults is from one grain gradually increased to three or four. Ricord gave from one-sixth to one-half of a grain to children of six months old. Biett employed it internally, and also externally, in the form of ointment, to the extent of twelve or fourteen grains daily, by way of friction.

1. **PILULÆ HYDRARGYRI IODIDI**, L. (Iodide of Mercury, ʒj.; Confection of Dog-rose, ʒiij.; Ginger, powdered, ʒj. M.)—Five grains of these pills contain one grain of iodide. The dose, therefore, will be from five grains to a scruple.

2. **UNGUENTUM HYDRARGYRI IODIDI**, L. (Iodide of Mercury, ʒj.; White Wax, ʒij.; Lard, ʒvj. M.)—This is used as a dressing for scrofulous ulcers, or for syphilitic ulcers in scrofulous subjects. It is also employed in tubercular skin diseases, as lupus, rosacea, and sycosis[i].

13. HYDRAR′GYRI BINIO′DIDUM, *L.E.*—BINIODIDE OF MERCURY.

HISTORY.—This compound is frequently called the *Deutiodide of Mercury*, or the *Red* or *Per-Iodide of Mercury*.

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[d] Cogswell, *Essay on Iodine and its Compounds*, p. 160.
[e] Biett, *Lancette Française*, Juin 1831.
[f] *Essays on the Effects of Iodine in Scrofulous Disorders*, by Dr. O'Shaughnessy, p. 170.
[g] *Lancette Française*, 1835, No. 65.
[h] O'Shaughnessy's *Trans. of Lugol's Essays*, p. 201.
[i] Rayer, *Treat. on Skin Diseases*.

Preparation.—Both the London and Edinburgh Colleges give directions for the preparation of this compound.

The *London College* orders of Mercury, ℥j.; Iodine, ʒx.; Alcohol as much as may be sufficient; rub the mercury and iodine together, adding the alcohol gradually, until the globules are no longer visible. Dry the powder immediately, with a gentle heat, without the access of light, and keep in a well-stoppered vessel.

The *Edinburgh College* directs of Mercury, ℥ij.; Iodine, ℥ijss.; Concentrated Solution of Muriate of Soda, *a Gallon.* Triturate the Mercury and Iodine together, adding occasionally a little rectified spirit till a uniform red powder be obtained. Reduce the product to fine powder, and dissolve it in the solution of muriate of soda with the aid of brisk ebullition. Filter, if necessary, through calico, keeping the funnel hot; wash and dry the crystals which form on cooling.

In these processes the iodine and mercury combine, to form the biniodide. The alcohol facilitates the combination by dissolving part of the iodine, and forming a pasty mass with the remainder.

The solution of common salt employed by the Edinburgh College serves to separate the biniodide from any protiodide (which is insoluble in that liquid) as well as to obtain the biniodide in a crystalline form.

Considerable inconvenience is experienced in obtaining large quantities of the biniodide by the above process, on account of the great heat evolved when mercury and iodine are rubbed together (see p. 778).

Biniodide of mercury may be readily obtained by mixing solutions of bichloride of mercury and iodide of potassium. 1 eq. or 274 parts of bichloride are required to decompose 2 eqs. or 332 parts of iodide of potassium. These proportions are about eight of the first, to ten of the second salt. In this process double decomposition takes place: 1 eq. or 454 parts of biniodide of mercury precipitate, and 2 eqs. or 152 parts of chloride of potassium remain in solution.

In order to obtain a fine-coloured biniodide, and to ensure the absence of bichloride of mercury in the product, a slight excess of iodide of potassium should be employed. This, indeed, holds a little biniodide of mercury in solution, but the quantity is inconsiderable. A large excess of iodide of potassium combines with the biniodide, and forms therewith a soluble double salt (*hydrargyro-iodide of potassium*) composed of iodide of potassium and biniodide of mercury. If the bichloride of mercury be slightly in excess, a pale-red precipitate (composed of biniodide of mercury with a little bichloride) is obtained. A great excess of bichloride of mercury keeps biniodide in solution.

Properties.—It is a scarlet red powder, whose sp. gr. is 6·32. It is insoluble in water, but soluble in alcohol, some acids, alkalis, and solutions of iodide of potassium, chloride of sodium, and of many of the mercurial salts. From its solution in boiling rectified spirit it is deposited, on cooling, in rhombic prisms. When heated it fuses, forming a ruby-red liquid, sublimes in crystals, which are at first yellow but afterwards become red, and furnish a scarlet-red powder. It combines with other alkaline iodides (as iodide of potassium) forming a class of double salts, called the *hydrargyro-iodides.*

Characteristics.—Heated with potash in a tube it yields metallic mercury, which is volatilized: the residue is iodide of potassium, recognisable by the tests before described (p. 490). From the protiodide of mercury it is distinguished by its colour and its solubility in a solution of chloride of sodium. The effects of heat on it, and its solubility in iodide of potassium, are other characters which serve to recognise it.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Mercury	1	202	44·5
Iodine	2	252	55·5
Biniodide of Mercury	1	454	100·0

PURITY.—The presence of bisulphuret of mercury in it may be recognised by fusion with caustic potash in a glass tube, by which a mixture of sulphuret and iodide of potassium is obtained: the existence of sulphur may be proved by the evolution of hydrosulphuric acid on the addition of a mineral acid.

By heat, cautiously applied, it is sublimed in scales, which soon become yellow, and afterwards, when they are cold, red. It is partially soluble in boiling rectified spirit, which affords crystals as it cools. It is alternately dissolved and precipitated by iodide of potassium and bichloride of mercury. It is totally soluble in chloride of sodium. *Ph. Lond.*

"Entirely vaporizable: soluble entirely in 40 parts of a concentrated solution of muriate of soda at 212°, and again deposited in fine red crystals on cooling."—*Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—A scruple killed a rabbit in twenty-four hours: the stomach was found preternaturally reddened. Ten grains, dissolved in a solution of iodide of potassium, and given to a dog, caused vomiting, pain, tenesmus, and depression: in four or five days the animal was well[j]. Maillet[k] has also made some experiments with it

β. On Man.—It is a powerful irritant and caustic. It is nearly as powerful as the bichloride of mercury; indeed, Rayer[l] considers it more active than the latter. Applied to ulcers, in the form of ointment, I have known it cause excruciating pain. Left in contact with the skin for a while, it induces, says Rayer, a most intense erysipelatous inflammation. When administered internally, it must be done with great caution. Like other mercurial compounds, its repeated use causes salivation.

USES.—It has been employed in the same cases (*i. e.* syphilis and scrofula) as the protiodide of mercury, than which it is much more energetic. Breschet[m] applied it, in the form of ointment, with great success in a case of obstinate ulceration (thought to have been carcinomatous) of the angle of the eye. In the form of a dilute and thin ointment (composed of biniodide of mercury, gr. ii.; cerate, ℈ii.; and almond oil, ℈i.) it has been used in opacity of the cornea[n]. In obstinate ophthalmia tarsi, with thickening of the meibomian glands, it has also been successfully employed.

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[j] Cogswell, *Essay on Iodine*, p. 164.

[k] *Journ. de Chim. Méd.* iii. 543, 2de Série.

[l] *Treatise on Skin Diseases*, by Dr. Willis, p. 79.

[m] O'Shaughnessy's *Transl. of Lugol's Essays*, p. 204.

Administration.—It should be given in doses of one-sixteenth of a grain, gradually increased to one-fourth of a grain. It may be exhibited in the form of pills, or dissolved in alcohol or ether.

UNGUENTUM HYDRARGYRI BINIODIDI, *L.* (Biniodide of Mercury, ℥j.; White Wax, ℥ij.; Lard, ℥vj. M.) Used in the before-mentioned cases. For ordinary purposes it will require to be considerably diluted.

14. HYDRAR'GYRI BISULPHURE'TUM, *L.*—BISULPHURET OF MERCURY.

(Cinnabaris, *E.*—Hydrargyri Sulphuretum rubrum, *D.*)

History.—It is mentioned in the Old Testament[o]. Theophrastus[p] says that *Cinnabar* (κιννάβαρι) was accidentally discovered, by Callius, about ninety years before the magistracy of Praxibulus, of Athens—that is, 494 years before Christ. Geiger[q] found it in the colouring matter of the old Egyptian tombs. It was formerly called *Minium*[r]. It is commonly termed *Red Sulphuret of Mercury;* and, when in powder, *Vermilion.*

Natural History.—The principal repositories of *Native Cinnabar* (*Cinnabaris nativa*) are Idria, in Carniola, and Almaden, in Spain. It occurs both massive and crystallized: the primary form of its crystals being the acute rhombohedron.

Preparation.—All the British Colleges give directions for the preparation of this compound.

The *London College* orders of Mercury, lbij.; Sulphur, ℥v. Melt the Sulphur, add the mercury, and continue the heat till the mixture begins to swell up. Then remove the vessel, and cover it closely to prevent the mixture taking fire. When the material is cold, reduce it [the mass] to powder, and sublime it.

The process of the *Edinburgh College* is similar.

The *Dublin College* orders of Purified Mercury, *nineteen parts;* Sublimed Sulphur, *three parts.* Mix the mercury with the melted sulphur, and, if the mixture takes fire, extinguish the flame by covering the vessel. Reduce the product of this operation to powder, and sublime it.

In this process the heat enables the mercury and sulphur to combine and form a black sulphuret of mercury. When large quantities of sulphur and mercury are heated together, a slight explosion and flame are produced. By sublimation the black sulphuret is converted into cinnabar or the red sulphuret[s].

Properties.—Artificial cinnabar has, in the mass, a dark reddish brown crystalline appearance; but, when reduced to a fine powder, is of a beautiful scarlet-red colour, and is then termed *Vermilion.* It is tasteless, odourless, insoluble in water or alcohol, and unalterable in the air. It is fusible and volatile. It burns in the air with a blue flame, the sulphur uniting with oxygen to form sulphurous acid, while the mercury is dissipated in a vaporous form.

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[n] Graefe and Walther's *Journ. f. Chir.* Bd. 13.

[o] *Jerem.* xxii. 14.

[p] *De Lapidibus.*

[q] *Handb. d. Pharm.*, by Liebig.

[r] Pliny, *Hist. Nat.* lib. xxxiii. cap. 38, ed. Valp.

[s] Full details respecting the Dutch method of manufacturing cinnabar are given in the *Ann. de Chim.* iv. 25; and in Aikin's *Dict. of Chemistry,* vol. ii. p. 87.

Characteristics.—Heated in a glass tube, with potash, it evolves mercurial vapour, which condenses into liquid globules of this metal. The residue, which is sulphuret of potassium, gives out hydrosulphuric acid on the addition of hydrochloric acid. The colour of cinnabar deepens under the influence of heat.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Guibourt.*	*Sefström.*
Mercury	1	202	86·32	86·21	86·29
Sulphur	2	32	13·67	13·79	13·71
Bisulphuret of Mercury	1	234	99·99	100·00	100·00

PURITY.—Pure cinnabar is totally evaporated by heat, and is insoluble in nitric or hydrochloric acid. If minium or red lead be intermixed, we may recognise it by boiling in acetic acid, by which acetate of lead is procured in solution: this forms a black precipitate with hydrosulphuric acid,—white with the sulphates,—and yellow with iodide of potassium. Realgar, or sulphuret of arsenicum, may be detected by boiling the suspected cinnabar in solution of caustic potash, supersaturating with nitric acid, and passing a current of hydrosulphuric acid through it, by which a yellow precipitate (*orpiment* or *sesquisulphuret of arsenicum*) is obtained. Earthy impurities are not volatile.

Totally evaporated by heat; and on potash being added to it, it runs into globules of mercury. It is not dissolved either by nitric or hydrochloric acid, but is so by a mixture of them. Rectified spirit, with which it has been boiled or washed, acquires no red colour. Digested with acetic acid it yields no yellow precipitate by iodide of potassium. *Ph. Lond.*

"It is sublimed entirely by heat, and without any metallic globules being formed." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—According to Orfila [s], pure cinnabar is inert: for he found no effects were produced on dogs, by half an ounce, when either applied to wounds, or taken into the stomach. These results being opposite to those obtained by Smith [t], it has been presumed that the latter must have employed an impure sulphuret.

The vapour obtained by heating cinnabar in the air is poisonous; but this is not in opposition to Orfila's experiments, since this vapour is not bisulphuret of mercury, but a mixture of the vapour of mercury (either in the metallic or oxidized state) and of sulphurous acid gas. Schenkius [u] has related the case of a young man who died from the use of this vapour; and Hill [v] saw cough, violent salivation, diarrhœa, &c. produced by its inhalation.

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[s] *Archiv. Gén. de Méd.* xix. 330.

[t] Christison, *Treat. on Poisons,* 3d ed. 395.

[u] *Observ.* L. vii.

[v] *Edin. Med. Essays,* iv.

Uses.—Cinnabar is used merely as a fumigating agent, in venereal ulcerations of the nose and throat. The method of using it is this: —About half a drachm is placed on a heated iron, and the fumes inhaled as they arise. In the shops, a copper apparatus, with iron heater, is sold for the purpose. In the absence of this, the bisulphuret is to be placed on a hot iron shovel, and the vapour inhaled by the patient through a funnel. The irritating nature of the sulphurous vapour usually excites coughing, and is injurious in persons disposed to phthisis. Hence the oxide of mercury is to be preferred for fumigating.

Administration.—When employed internally, cinnabar has been given in doses of from ten grains to half a drachm. For the purpose of fumigation, half a drachm may be employed.

15. HYDRAR'GYRI SULPHURE'TUM CUM SUL'PHURE, *L.*—BISULPHURET OF MERCURY WITH SULPHUR.

(Hydrargyri Sulphuretum nigrum, *D.*)

History.—It is stated that the Chinese used this remedy long before it was known to Europeans. Harris, in 1689, first taught the method of preparing it by trituration. Its most common name is *Æthiops mineral.*

Preparation.—The London and Dublin Colleges give directions for the preparation of this compound.

The *London College* orders of Mercury; Sulphur, each, lbj. Rub them together, until globules are no longer visible.

The directions of the *Dublin College* are similar, with the addition that a stoneware mortar should be used.

Properties.—It is a heavy, black, tasteless, odourless powder, insoluble in water. When heated it fuses, and is completely dissipated.

Characteristics.—By boiling in caustic potash liquor we obtain a solution of sulphuret of potassium. The residue is black, but possesses all the before-mentioned chemical characteristics of cinnabar (*vide* p. 763).

Composition.—If this compound be, as Mr. Brande[w] supposes, a mixture of bisulphuret of mercury and sulphur, the proportions must be—

	Per Cent.
Bisulphuret of Mercury	58
Sulphur	42
Hydrargyri Sulphuretum cum Sulphure, *Ph. Lond.*	100

Purity.—Free mercury may be detected by its communicating a white stain to gold. Charcoal may be detected by its not volatilizing by heat. Animal charcoal, by this character, as well as by the presence of phosphate of lime in the residue (*vide* pp. 332 and 600). Sesquisulphuret of antimony may be recognised by boiling in hydrochloric acid, and applying the before-mentioned (p. 654) tests for sesquichloride of antimony.

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[w] *Manual of Pharmacy,* 3d ed. 329.

Totally evaporated by heat, no charcoal nor phosphate of lime being left. *Ph. Lond.*

Physiological Effects.—According to the experiments of Orfila, this preparation, like the last, possesses little or no activity. The late Dr. Duncan[x] also tells us that he has given it in doses of several drachms, for a considerable length of time, with scarcely any effect. It is commonly regarded as alterative.

Uses.—It has been used in glandular diseases, especially of children; and also in cutaneous diseases.

Administration.—The dose for adults is from 5 to 30 grs.

16. HYDRAR'GYRI BICYAN'IDUM, *L.*—BICYANIDE OF MERCURY.

(Hydrargyri Cyanuretum, *D.*)

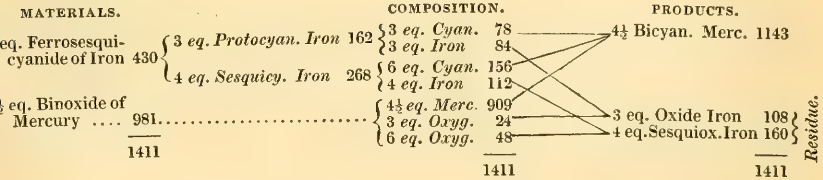
History.—This salt was discovered by Scheele. Its real nature was first pointed out by Gay-Lussac in 1815. It has been known by various appellations, as *Prussian Mercury* (*Hydrargyrum Borussicum*), *Prussiate*, *Hydrocyanate*, *Cyanuret*, *Cyanide* or *Cyanodide of Mercury* (*Hydrargyri Prussias*, *Hydrocyanas*, *Cyanuretum*, *Cyanidum* seu *Cyanodidum*).

Preparation.—There are two methods of preparing this salt: one recommended by Proust, the other by Winckler. The London and Dublin Colleges adopt Proust's process.

The *London College* orders, of Percyanide of Iron [*Prussian Blue*], ℥viij.; Binoxide of Mercury, ℥x.; Distilled Water, Oiv. Boil them together for half an hour and strain. Evaporate the liquor that crystals may be formed. Wash what remains frequently with boiling distilled Water, and again evaporate the mixed liquor that crystals may be formed.

The *Dublin College* employs of Prussian Blue, *six parts*; Nitric Oxide of Mercury, *five parts*; Distilled Water, *forty parts*.

In this process the cyanogen of the Prussian blue combines with the mercury of the nitric oxide, while the iron unites with the oxygen of the oxide.



The awkwardness of the use of half an equivalent may be easily obviated by doubling all the above numbers; but several reasons have induced me to retain it in the above diagram.

Pure bicyanide of mercury may be more economically prepared by Winckler's process. This consists in saturating hydrocyanic acid with binoxide of mercury.

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[x] *Edinburgh Dispensatory.*

The *London College* observes that bicyanide of mercury may be otherwise prepared by adding as much Binoxide of Mercury as will accurately saturate it, to Hydrocyanic Acid, distilled from Ferrocyanide of Potassium with diluted Sulphuric Acid.

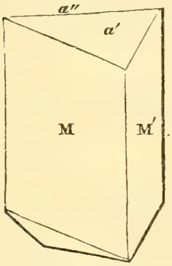
The solution is to be filtered and allowed to crystallize.

In this process double decomposition takes place, the resulting products being water and bicyanide of mercury.

MATERIALS.		COMPOSITION.		PRODUCTS.	
2 eq. Hydrocyanic acid	54	*2 eq. Hydrogen*	2	2 eq. Water	18
		2 eq. Cyanogen	52		
1 eq. Binoxide Mercury	218	*2 eq. Oxygen*	16		
		1 eq. Mercury	202	1 eq. Bicyanide of Mercury	254
	272		272		272

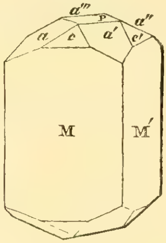
PROPERTIES.—The crystals of this salt are square prisms. The crystals are heavy, white, colourless, transparent or opake, inodorous, and have a strong metallic taste. They are soluble in water, both hot and cold, and very little, if at all so, in alcohol.

FIG. 124.



General form of Crystals of Bicyanide of Mercury.

FIG. 125.



Crystals with modified Planes.

Characteristics.—Perfectly dry bicyanide of mercury when heated yields metallic mercury and cyanogen gas. The latter is known by the violet or bluish red colour of its flame. Heated with hydrochloric acid it evolves hydrocyanic acid. It is not decomposed by nitric acid or the alkalis. Its solution throws down a black precipitate with hydrosulphuric acid, and white pearly crystalline plates (*hydrargyro-iodo-cyanide of potassium*) with a concentrated solution of iodide of potassium (*vide* p. 434).

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*
Mercury	1	202	79·52	79·91
Cyanogen	2	52	20·47	20·09
Bicyanide of Mercury	1	254	99·99	100·00

PURITY.—When prepared from ferrosesquicyanide of iron (Prussian blue) the crystals are usually yellowish, from the presence of some oxide of iron.

Transparent and totally soluble in water. The solution, when hydrochloric acid is added, emits hydrocyanic acid, which is known by its peculiar smell; and a glass moistened with the solution of nitrate of silver and placed over it, gives a deposit, which is dissolved by boiling nitric acid. By heat it emits cyanogen, and runs into globules of mercury. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—It acts on plants like bichloride of mercury[y].

β. *On Animals.*—Coulon[z] found that it acted on dogs, cats, sparrows, frogs, snails, &c. like hydrocyanic acid. After death, inflammation of the stomach was observed. Ollivier d'Angers[a] tried its effects on dogs. Seven grains, dissolved in water, killed a small dog in ten minutes, under attempts to vomit, general convulsions, and exhaustion, manifested alternately; respiration and circulation at first accelerated, afterwards diminished. Similar effects were produced by applying the salt to the cellular tissue, or injecting it into the veins. Tiedemann and Gmelin[b] detected mercury in the blood of the splenic vein of a horse to whom the bicyanide had been administered.

γ. *On Man.*—Taken in *small doses*, it very readily excites nausea and vomiting. Parent[c] says it does not produce the epigastric pain which the bichloride of mercury readily occasions. Continued use causes salivation. In one case one-eighth of a grain twice a day caused ptyalism in three days[d]. Mendaga[e] says it acts directly on the skin and bones, and hence it sometimes very speedily allays the pain of and disperses nodes.

In large doses, especially in very susceptible persons, it affects the nervous system, and causes fainting, anxiety, and cramps. Twenty-three and a half grains in one instance[f] caused death in nine days. The most remarkable symptoms were, obstinate vomiting; mercurial ulceration of the mouth and abundant ptyalism; contractions of the heart, which at first were very strong, but became successively slower and more feeble; the abdomen was yielding, and not tender, notwithstanding the constant tenesmus; suppression of urine; semi-erection of the penis, and ecchymosis of this organ, as well as of the scrotum; and, ultimately, convulsive movements.

USES.—It has been employed as an *antivenereal* medicine, and was first used as such by Brera[g]. Parent[h] administered it as a substitute for the bichloride of mercury, over which it has several advantages. Thus, being more soluble, it ought to be more readily absorbed: it does not give rise to epigastric pain; and, lastly, it is not so readily decomposed; for alkalis, several salts, and many solutions of organic matters, which decompose corrosive sublimate, have no effect on it. It may be applied in the form of aqueous solution or ointment to venereal sores.

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[y] Gœppert, in De Candolle, *Phys. Vég.* 1834.
[z] *Traité sur l'Acide Prussique*, quoted by Wibmer, *Wirk. d. Arzneim.* iii. 30.
[a] *Journ. de Chim. Méd.* i. 269.
[b] *Versuche ü. d. Wege auf welch. Subst. aus d. Magen u. Darmk. ins Blut gelang.*
[c] *Journ. de Chim. Méd.* viii. 473.
[d] Neumann, in Dierbach's *Neueste Entd. in d. Mat. Med.* ii. 483, 1828.
[e] *Decades Medico-chirurgicas y Farmaceuticas* vi. 319, in Richter's *Ausführ Arzneim.* v. 477.
[f] *Journ. de Chim. Méd.* i. 210.
[g] Richter, *op. cit.*
[h] *Journ. de Chim. Méd.* viii. 473.

It has been employed in induration of the liver, in some chronic skin diseases, in obstinate headache, and in other maladies, as an antiphlogistic.

Its principal use in this country is as a source of hydrocyanic acid (*vide* p. 431) and of cyanogen gas.

Administration.—Internally it may be employed in doses of one-sixteenth of a grain gradually increased to one-half of a grain. It may be administered in the form of pills (made with crumb of bread) or alcoholic solution. It will be frequently advisable to conjoin opium, to prevent nausea or vomiting. When used as a *gargle* or *wash*, we may employ ten grains to a pint of water. An *ointment* may be prepared of ten or twelve grains to an ounce of lard.

Antidote.—I am unacquainted with any antidote for it. Albumen does not decompose it. Perhaps ammonia might be found serviceable, to diminish the effect on the nervous system. Opium relieves the vomiting. Our principal object must be remove the poison from the stomach, which is to be effected by the stomach-pump, emetics, tickling the throat, &c.

17. UNGUEN′TUM HYDRAR′GYRI NITRA′TIS, *L.*—OINTMENT OF NITRATE OF MERCURY.

(Unguentum Citrinum, *E.*—Unguentum Hydrargyri Nitratis vel Unguentum Citrinum, *D.*)

History.—This ointment is commonly known as *Citrine* or *Yellow Ointment*. It has also been termed *Mercurial Balsam*.

Preparation.—All the British Colleges give directions for its preparation.

The *London College* orders of Mercury, ℥j.; Nitric Acid, fʒxi.; Lard, ℥vj; Olive Oil, f℥iv. First dissolve the Mercury in the Acid; then mix the solution while hot with the Lard and Oil melted together.

The *Edinburgh College* directs of Pure Nitric Acid, f℥viij. and fʒvi.; Mercury, ℥iv.; Axunge, ℥xv.; Olive Oil, f℥xxxij. Dissolve the mercury in the acid with the aid of a gentle heat. Melt the axunge in the oil with the aid of a moderate heat in a vessel capable of holding six times the quantity; and while the mixture is hot, add the solution of mercury, also hot, and mix them thoroughly. If the mixture do not froth up, increase the heat a little till this take place. Keep this ointment in earthenware vessels, or in glass-vessels, secluded from the light.

The *Dublin College* orders of Purified Mercury, *by weight*, ℥j.; Nitric Acid, ʒxiss.; Olive Oil, Oj. [*wine measure*]; Prepared Hog's Lard, ℥iv. Dissolve the mercury in the acid; then, having melted the oil and lard together, mix them and make an ointment in the same manner as the ointment of nitric acid.

The *theory* of the process is as follows:—By the mutual action of mercury and strong nitric acid, a nitrate of the binoxide, as well as of the protoxide of mercury, is formed, while binoxide of nitrogen is generated[1]. Part of the latter escapes, and, combining with atmospheric oxygen, forms nitrous acid; the remainder reacts on the free nitric acid, and forms with it hyponitrous or nitrous acid. The liquor then is a mixture of *nitric acid* in excess, probably of *nitrous acid*, of the *nitrate* and *hyponitrite of the binoxide of mercury*, and *nitrate of the protoxide of mercury*.

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[1] For the theory of the formation of *Protonitrate of Mercury*, see pp. 734, 739, and 756.

When this solution is added to the fatty matter (lard and olive oil), the olein (*oleate of glycerine*) of the olive oil and of the lard is transformed into elaïdine[j] (*elaïdate of glycerine*) by the nitrous or hyponitrous acid of the solution. A red viscid oil is also simultaneously developed. Binoxide of nitrogen, and, according to Soubeiran[k], carbonic acid gases are evolved. By the action of the fatty bodies on nitrate of mercury the latter is transformed into a yellow subnitrate of the protoxide of mercury. A small portion of elaïdate of mercury is also formed. The continued deoxidizing influence of the fats on the mercurial salt ultimately effects the reduction of the mercury. The grey colour which the ointment acquires by keeping is due to the dissemination of minute globules of metallic mercury through the mass. If old citrine ointment be digested in ether, the fatty matters are dissolved, and metallic mercury left behind.

By keeping, this ointment is apt to change its colour, and become hard, pulverizable, and thereby unfit for use. To prevent these alterations various modifications of the officinal formulæ above given have been suggested. Dr. A. T. Thomson[l] declares that the proportion of lard used is too large. This statement, however, is pronounced by Dr. Wood[m] to be a mistake; and the hardening is ascribed to the olive oil. In the United States Pharmacopœia neat's-foot oil is substituted for olive oil, and it is said with decided advantage.

One writer recommends rape oil[n]. Mr. Lessey, of Manchester, informs me, that when made with lard only, the ointment remained soft for six months. MM. Henry and Guibourt[o], and Mr. Duncan, of Edinburgh[p], employ a considerable excess of acid. The following are several formulæ for its preparation:—

	United States Dispensatory.	*Paris Codex.*	*Henry and Guibourt.*	*Duncan.*	*Bell and Co.*[q]	*Lessey.*
Mercury	℥j.	32 parts.	30 parts.	℥iv.	℥viii.	ʒiv.
Nitric Acid . .	fʒxi. (sp. gr. 1·5)	48 parts. (sp. gr. 1·286)	60 parts. (sp. gr. 1·321)	℥xii. (Nitrous acid)	fʒxiv. (sp. gr. 1·43)	ʒxij. (Nitrous acid)
Lard	℥iij.	250 parts.	240 parts.	℥xv.	lb. iij.	℥xliss.
Olive Oil	0	250 parts.	240 parts.	℥xxxviss.	lb. ij.	0
Neat's-foot Oil,	f℥ix.	0	0	0	0	0

Fine citrine ointment may be procured by any of the above processes; but, on the other hand, failure may attend all of them. This may arise either from defective manipulation or from the employment of acid of different strength to that ordered. The following are some practical points to be attended to in conducting the process[r]:—

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[j] So called by Boudet (*Journ. de Chim. Méd.* viii. 641) from ἐλαΐς, ἐλαΐδος, *an olive tree.*

[k] *Nouv. Traité de Pharmacie*, t. ii. p. 526, 2nde éd.

[l] *London Dispensatory.*

[m] *United States Dispensatory.*

[n] *Pharmaceutical Transactions*, No. iv. p. 175.

[o] *Pharmacopée Raisonnée*, p. 448, 3me éd.

[p] *Supplement of the Edinburgh Dispensatory*, p. 196.

[q] *Pharmaceutical Transactions*, No. iii. p. 102.

1. *The due regulation of the heat employed.*—"If the mixture be made at a low temperature, no effervescence takes place, and the ointment so produced will become hard in a few days, of a greenish white colour, and eventually of a consistence that may almost be powdered; but if the oil or fat is heated to a sufficient temperature, or the quantity operated upon is large enough to generate the heat required, strong effervescence takes place, much gas is evolved, and a perfect article is produced, of a fine golden colour, and the consistence of butter." The greater success which attends the manufacture of large than of small quantities of this ointment, may be referred to the higher temperature generated by the reaction of larger quantities of the materials.

2. *The employment of a proper quantity of acid.*—In the process of the London College, by which, when it is strictly followed, a very fine product is obtained, acid of a sp. gr. of 1·5 is directed to be used. But the sp. gr. of commercial nitric acid rarely exceeds 1·38 or 1·4. Hence, therefore, a larger quantity of commercial acid is required to be equivalent to the quantity of strong acid ordered by the Pharmacopœia.

3. *Stirring assists the evolution of gas, and is usually believed to favour the formation of a fine product.*—Mr. Alsop, however, asserts that a long-continued stirring is not required.

Properties.—When fresh prepared this ointment has a fine golden yellow colour, a butyraceous consistence, and a remarkable nitrous odour. It is very apt to become grey when mixed with other ointments, in consequence of their deoxidizing powers. It should be spread with wooden or ivory spatulas.

Composition.—When fresh prepared this compound contains the following substances:—

Elaïdine.
Red oil.
Elaidate of mercury (mercurial soap).
Nitrate of Mercury.

Elaïdine is a white saponifiable fat, fusible at 97° F. [89·6 F. according to Meyer[s]], very soluble in ether, but requiring 200 times its weight of boiling alcohol to dissolve it. It consists of elaïdic acid and glycerin.

Physiological Effects.—It is an irritant and slight caustic. When it has undergone decomposition by keeping, it irritates ulcers exceedingly, and even excites slight erysipelatous inflammation.

Uses.—We employ it as a stimulant and alterative in *chronic diseases of the skin*, more particularly those affecting the hairy scalp, as the different forms of porrigo, in which it is exceedingly efficacious. It is also used as a *dressing to ulcers*—to stimulate and cleanse them—as in foul syphilitic sores and phagedenic ulcers. Lastly, it is employed in *ophthalmic diseases*—more particularly ophthalmia tarsi, or psorophthalmia, in which it is applied (mixed with its own weight of almond oil) by means of a camel's-hair pencil to the lids, frequently with such advantage that some have regarded it as a specific in this complaint.

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[r] See Mr. Alsop's paper in the *Pharmaceutical Transactions*, No. iii. p. 100.
[s] *Pharmaceutisches Central-Blatt für* 1840, S. 790.

18. HYDRAR'GYRI ACE'TAS, *D.*—ACETATE OF MERCURY.

History.—This compound was known to Lefebure in the 17th century.

Preparation.—In the *Dublin Pharmacopœia* the directions for procuring it are the following:—

> Take of Purified Mercury, Acetate of Potash, of each nine parts; Diluted Nitric Acid, eleven parts; Boiling Distilled Water, one hundred parts; Distilled Vinegar, as much as may be sufficient.
>
> Let the Nitric Acid be added to the Mercury, and when the effervescence has ceased, let the mixture be digested that the metal may be dissolved: let the Acetate of Potash be dissolved in water, and let the distilled vinegar be added until the acid shall predominate in the liquor; to this, whilst boiling, let the solution of the Mercury in the Nitric Acid be added, and let the mixture be filtered as quickly as possible through a double linen cloth; let it cool that crystals may form; having washed these with cold distilled water, dry them on paper with a very gentle heat. In every step of this process let glass vessels be employed.

By the mutual action of diluted nitric acid and mercury we obtain a protonitrate of mercury (*vide* p. 734). When this is mixed with acetate of potash double decomposition takes place: nitrate of potash and protoacetate of mercury being formed. To prevent precipitation of the yellow subnitrate of mercury, excess of acetic acid should be employed: and by filtering, whilst hot, any which may be formed would be separated before the acetate has deposited.

Properties.—This salt occurs in white, micaceous, flexible scales, which are inodorous, but have an acrid taste. It blackens by light. When heated it is resolved into carbonic acid, acetic acid, and mercury. It is very slightly soluble in water, requiring 300 times its weight of this liquid to dissolve it, according to Dumas. It is insoluble in cold alcohol: boiling alcohol abstracts part of its acid.

Characteristics.—Its appearance, its slight solubility in water, and the action of heat on it, are some of its characteristics. Heated with sulphuric acid the vapour of acetic acid is evolved. The fixed alkalis precipitate the black oxide of mercury. Chloride of sodium forms calomel with it.

Composition.—It has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Dumas.*
Protoxide of Mercury	1	210	80·46	80·66
Acetic Acid	1	51	19·54	19·34
Acetate of Mercury	1	261	100·00	100·00

Physiological Effects.—It is one of the mild mercurial prepations. From the reports of Guarin, Colombier, and Vogler[t], it appears to have acted in some cases with great violence, and to have occasioned violent vomiting, purging, abdominal pain, bloody evacuations, &c. These effects probably arose from the presence of some acetate of the binoxide of mercury.

Uses.—It was introduced into practice in consequence of being supposed to be the active ingredient of Keyser's antivenereal pills. But Robiquet has subsequently ascertained that Keyser employed the acetate of the binoxide[u]. It is occasionally used in syphilitic affections.

Administration.—The dose of it is from one to five grains. A solution composed of one grain of the acetate dissolved in an ounce of water, may be used as a *wash*. An *ointment* is prepared by dissolving two or three scruples in an ounce of olive oil.

19. HYDRAR'GYRI SUBSUL'PHAS FLAVUS.—YELLOW SUBSULPHATE OF MERCURY.

(Hydrargyri Oxydum Sulphuricum, *D.*)

History.—This compound was known to Croll in the sixteenth century. It has been termed *Turpeth* (or *Turbith*) *mineral* (*Turpethum minerale*), from its resemblance in colour to the root of the *Ipomœa Turpethum.*

Preparation. — The *Dublin College* directs it to be thus prepared:—

> Take of the Persulphate of Mercury one part, Warm Water twenty parts. Triturate them together in an earthenware mortar, and pour off the supernatant liquor; let the yellow powder be washed with distilled water, so long as the decanted fluid exhibits any deposit on the addition of some drops of the water of caustic potash; lastly, let the sulphuric oxide of mercury be dried.

By the action of water there are obtained a soluble supersulphate and a difficulty soluble subsulphate of mercury.

Properties.—It is a heavy, lemon-yellow, inodorous powder, having an acrid taste. It requires 2000 parts of water at 60°, or 600 parts at 212°, to dissolve it.

Characteristics.—When heated in a tube, sulphurous acid is evolved, and globules of mercury sublimed. Boiled with caustic potash or soda, the red binoxide precipitates, and a solution of sulphate of potash is obtained, known to be a sulphate by chloride of barium (*vide* p. 469).

Composition.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Braamcamp and Siqueira-Oliva.*
Binoxide of Mercury	1	218	84·5	84·7
Sulphuric Acid	1	40	15·5	15·
Subsulphate of Mercury	1	258	100·0	99·7

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[t] Wibmer, *Wirkung d. Arzneim.* iii. 647.

[u] Dumas, *Traité de Chimie*, v. 178.

Physiological Effcts.—In small quantities it occasions nausea, vomiting, and ptyalism. Taken into the nostrils it excites sneezing, and sometimes salivation. Stenzel [v] mentions a fatal case from its internal use.

Uses.—It is sometimes used as an emetic in cases of swelled testicle, to promote absorption by its nauseating and emetic action [w]. It was formerly given at the commencement of a mercurial course. As an errhine it has been administered in chronic ophthalmia and affections of the brain; as incipient hydrocephalus. As an alterative it has been given in the scaly diseases (lepra and psoriasis).

Administration.—As an alterative, the dose should not exceed half a grain, or at most a grain. As an emetic, it is given to the extent of five grains; in which dose it causes violent vomiting. As an errhine, a grain should be mixed with four or five of some mild powder, as starch or liquorice powder. It is rarely given for any other purposes.

Order XXII. COPPER AND ITS COMPOUNDS.

1. CU'PRUM.—COPPER.

History.—*Cuprum*, or *Copper*, received its name from Κύπρος, from the island of Cyprus, where it was first discovered, or at least worked to any extent. It seems to have been known in the most remote ages of antiquity, for Moses [x] speaks of brass (an alloy of copper and zinc). The alchymists called it *Venus*.

Natural History.—It is found in both kingdoms of nature.

α. In the Inorganised Kingdom.—Copper is found in the metallic or reguline state, combined with oxygen, with sulphur, with selenium, with chlorine, or with oxygen and an oxyacid (carbonic, arsenic, phosphoric, sulphuric, or silicic).

β. In the Organised Kingdom.—It has been discovered in the ashes of most plants, as of Stavesacre, Rhatany, Flax, Nux-vomica, Hemlock, &c. Sarzeau has detected it in the blood of animals [y].

Preparation.—The copper of commerce is usually prepared from *copper pyrites* (the double sulphuret of copper and iron). The greater part of the ore raised in Cornwall is of this kind. It is roasted and then smelted, by which *coarse metal* is produced. This is calcined and again smelted, by which we obtain *fine metal*, or, when cast in sand, *blue metal*. By re-roasting and smelting, *coarse copper* is produced. These processes, of roasting and smelting, effect the expulsion of the sulphur and the oxidizement of the iron. The copper thus produced is melted and exposed to the air, to drive off any volatile matters by which *blistered copper* is obtained. It is *refined* or *toughened* by melting it and stirring with a birchpole [z].

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[v] Wibmer, *Wirk. d. Arzneim.* iii. 66.

[w] *Observ. on the Dublin Pharmacopœia.*

[x] Job, ch. xxviii.

[y] *Ann. de Chim.* xliv. 334.

[z] J. H. Vivian, *Ann. of Philosophy*, N.S. vol. v. p. 113.

Properties.—It is a brilliant, red metal, crystallizable in regular octohedra and cubes, having a specific gravity of 8·86 to 8·89; malleable and ductile; it has a nauseous, styptic taste, and a peculiar and disagreeable smell. It fuses at 1996° F. (*Daniell*); at a higher temperature it may be volatilized. Its equivalent is 32. It is combustible, and is readily oxidated. Acid, alkaline, saline, and fatty bodies, when placed in contact with it in the air, promote its union with oxygen; and, by dissolving a portion of the newly-formed oxide, acquire poisonous properties.

Characteristics.—Copper is easily recognized by its colour, and by its communicating a green tinge to flame. It dissolves in diluted nitric acid: the solution possesses the following properties:—It is blue, or greenish-blue; with potash or soda it yields a blue precipitate (*hydrated oxide of copper*); a small quantity of ammonia produces with it a similar bluish-white precipitate, but an excess redissolves it, forming a deep blue liquid (*cuprate of ammonia*): ferrocyanide of potassium occasions in it a reddish-brown precipitate (*ferrocyanide of copper*); the hydrosulphurets throw down a precipitate (*sulphuret of copper*); and, lastly, a polished iron plate plunged into the liquid, becomes coated with metallic copper.

Physiological Effects. α. **Of Metallic Copper.**—Metallic copper appears to produce no pernicious effects when taken internally, so long as it retains its metallic state, as many cases are recorded where coins of this metal have been swallowed, and retained for a considerable time, without any ill effects arising; and Drouard[a] gave as much as an ounce of finely-powdered copper to dogs of different ages and sizes, but none of them experienced any inconvenience therefrom.

Notwithstanding these facts, however, various effects have been attributed to it. Thus, Cothenius[b] says, copper filings operate by stool, urine, and saliva; and the late Professor Barton[c] was accustomed to relate an instance of a child, who, having swallowed a cent, continued for some time to discharge several pints of saliva. Lastly, Portal[d] mentions a case in which copper filings, incorporated with crumb of bread, acted powerfully on the system. I have no doubt but that the effects here mentioned arose from the oxidation of the metal by the acids of the alimentary canal.

β. **Of the Cupreous Compounds.**—Most, if not all, the preparations of copper are poisonous in large doses. The sulphuret and ferrocyanide are doubtful exceptions to this statement. If the cupreous preparations be used in *very small* doses, they sometimes give relief in certain diseases (principally of the nervous system), without obviously disordering the functions; in other words, in these instances the only apparent effect is the modification observed in the morbid condition. These are cases in which these preparations have been termed *tonic*, *antispasmodic*, or *alterative*, according to the nature of the disease; thus, in ague they have been termed tonic, in epilepsy antispasmodic, in dropsy alterative. The beneficial operation is presumed to be owing to some influence exerted by the remedy over the nervous system. The effects produced by the long-continued use of small doses of the preparations of copper have not been satisfactorily determined; they are said to be various affections of the nervous system (such as cramps or paralysis), alteration of the colour of the skin, chronic inflammation of the respiratory and digestive apparatus, slow fever, and wasting of the body. These symptoms constitute what has been termed *slow*, or *chronic poisoning by copper*. The smelters and workers in copper do not suffer from the vapour or emanation of this metal, as the workmen employed in the preparation of mercury, of arsenic, or of lead do, from the vapours of these metals: this, indeed, might be expected, when we consider how much more volatile the latter and their preparations are, than copper and its compounds. In *larger*, or full medicinal doses, these remedies act as *emetics*, exciting speedy vomiting, with less nausea than tartar emetic produces. In *still larger* quantities, these bodies act as poisons, giving rise to gastro-intestinal inflammation, and disordering the functions of the nervous system (especially the cerebro-spinal portion), constituting *acute poisoning by copper*. The usual symptoms are, a coppery taste, eructations, violent vomiting and purging, griping pains, cramps in the legs and thighs, headache, giddiness, convulsions, and insensibility; jaundice is occasionally observed. In some cases the cerebro-spinal symptoms precede those which indicate inflammation of the alimentary canal. In experiments made on animals, it has been observed that death was sometimes produced without any marks of local irritation; the symptoms being those indicative of a disordered condition of the nervous system. By some toxicologists these preparations are ranked among the *irritant* poisons, though Buchner[e], judging from Reiter's experiments, terms them astringent.

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[a] *Exper. et Observ. sur l'Empoisonnem. par l'Oxide de Cuivre.* Paris, 1802.

[b] Voigtel, *Arzneimittellehre.*

[c] Chapman, *Elem. of Therap.* ii. 457.

[d] Orfila, *Toxicol. Gén.*

Drouard, and others, were of opinion that the preparations of copper did not become absorbed, but Lebkuchner[f] has detected copper in the blood of the carotid artery of a cat, into whose bronchial tubes he had injected four grains of the ammoniacal sulphate; and Wibmer[g] has found it in the liver of animals to whom he had given the acetate for several weeks.

Post-mortem appearances.—In animals killed rapidly by these poisons, no morbid appearances are found, in consequence of death being produced by their action on the nervous system: but when the death was slow, marks of gastro-intestinal inflammation, and occasionally indications of inflammation of the brain, have been observed.

USES. *a.* **Of Metallic Copper.**—Copper filings, in doses of three or four grains, were formerly used in rheumatism, and also as an antidote against the effects of the bite of a mad dog.

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[e] *Toxicologie.*

[f] Christison, *Treatise on Poisons*, 3d ed. 433.

[g] *Wirk. d. Arzn.* ii. 244.

β. **Of the Cupreous Compounds.**—These preparations are used both as external and as internal remedies; externally as stimulants, astringents, styptics, and caustics; internally, as emetics, tonics or antispasmodics, and astringents. The particular cases will be noticed when treating of the individual preparations.

Antidotes.—The chemical antidote for the cupreous preparations is *albumen;* hence, the whites of eggs, and in the absence of these, milk, or even wheaten flour, should be employed. *Iron filings* have been proposed by Navier, by Payen and Chevallier, and subsequently by Dumas and Milne Edwards. The iron decomposes the cupreous salt, and precipitates the copper in the metallic (and, therefore, in an inert) state. The *ferrocyanide of potassium* is also said to be a good antidote: a drachm or two of it may be taken with safety, for it is not so poisonous as was at one time imagined. *Sugar* was proposed by Marcelin Duval as an antidote; its efficacy, though denied by Orfila and Vogel, has been lately reasserted by Postel. The alkaline sulphurets formerly used are worse than useless, since they are active poisons. The inflammatory symptoms are of course to be subdued by the usual means[h].

2. CU'PRI SUL'PHAS, *L. E. D.*—SULPHATE OF COPPER.

History.—This substance was probably employed by Hippocrates[i], under the name of χαλκῖτις κυανέη (*Chalcitis cærulea*), to promote the healing of ulcers. Pliny[j] also was doubtless acquainted with it, though he seems to have confounded it with sulphate of iron. His *Chalcanthum Cyprium* was, perhaps, sulphate of copper. This salt has had various other names, such as *Blue Vitriol* (*Vitriolum cæruleum*), *Roman Vitriol, Blue Copperas, Blue Stone, Bisulphate of Copper.*

Natural History.—It occurs in copper mines (as those of Cornwall, &c.) and is formed from sulphuret of copper by the joint agency of air and water. The cupreous solutions of copper mines are termed *waters of cementation.*

Preparation.—It may be prepared by evaporating the water found in, or issuing from, copper mines. It is also produced by roasting copper pyrites, lixiviating the residuum to dissolve the sulphate, and evaporating so as to obtain crystals. In this process both the sulphur and the copper of the pyrites abstract oxygen from the air, and become, the one sulphuric acid, the other oxide of copper: these by their union constitute the sulphate of copper.

Sulphate of copper is "occasionally prepared by dissolving in sulphuric acid an oxichloride of copper made for the purpose, by exposing sheet copper to the joint action of air and hydrochloric acid[k]." It is also obtained in large quantities in certain processes for refining gold and silver. For the following information respecting its production at the Mint I am indebted to the kindness of Professor Brande:—

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[h] For further details on this subject consult Christison's *Treatise on Poisons.*

[i] *De ulceribus.*

[j] *Hist. Nat.* xxxiv. 32.

[k] Brande's *Manual of Chemistry*, 5th edit.

> "A large quantity of sulphate of copper is occasionally obtained here, as follows:—When ingots of silver are found to contain a certain quantity of gold, they are melted, granulated, and boiled in sulphuric acid, by which sulphate of silver is formed, and the gold remains in a pulverulent form: the sulphate of silver is then decomposed by the immersion of copper plates; the silver is precipitated in a fine crystalline powder, washed, pressed into masses, and melted, and so affords pure silver, which is afterwards made standard by alloying it with copper, and used for the coinage: the resulting sulphate of copper is then crystallized and sold.
>
> "When gold ingots contain a certain quantity of silver, they undergo a similar process. Suppose a certain number of ingots of gold to contain 2 or 3 per cent. of silver,—instead of leaving it, as formerly, to constitute a part of the standard alloy, it pays to extract it, and substitute copper in its place. To get the silver out of the said ingots they are melted with about 3 parts of silver,—the resulting alloy is granulated and boiled in sulphuric acid,—the gold remains untouched, and all the silver is dissolved and converted into sulphate, which is decomposed by copper as before; so that here again sulphate of copper is obtained."

PROPERTIES.—This salt occurs in fine blue crystals, whose form is the doubly oblique prism. Its sp. gr. is 2·2. It has a styptic metallic taste, and reacts on litmus as an acid. By exposure to the air it effloresces slightly, and becomes covered with a greenish-white powder. When heated it loses its water of crystallization, and becomes a white powder (*pulvis sympatheticus*). By a very intense heat it is decomposed,—sulphurous acid and oxygen are evolved, and oxide of copper left. It dissolves in about 4 parts of water at 60°, and 2 parts of boiling water. It is insoluble in alcohol.

Characteristics.—Its characteristics are those of the sulphates (*vide* p. 469), and of the cupreous compounds (*vide* p. 774).

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Thomson.*	*Berzelius.*
Oxide of Copper	1	40	32	32	32·13
Sulphuric Acid	1	40	32	32	31·57
Water	5	45	36	36	36·30
Crystallized Sulphate of Copper	1	125	100	100	100·00

IMPURITY.—The commercial sulphate of copper sometimes contains traces of sulphate of iron. It may be detected by excess of ammonia, which throws down the oxide of iron, but dissolves the oxide of copper.

In the air it becomes slightly pulverulent, and of a greenish colour. It is totally soluble in water. Whatever ammonia throws down from this solution an excess of ammonia dissolves. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—It is poisonous to plants[1]: hence its use in preventing dry rot (*Merulius lachrymans*), by soaking timber in it, according to Mr. Margary's patent; and in destroying or preventing the Smut (*Uredo segetum*), or Bunt (*U. caries*), in corn, by immersing the grain in a weak solution of it: the solution is not made sufficiently strong to injure the seed.

β. On Animals.—This salt operates as a poison to animals. Six grains killed a dog in half an hour, without producing any appearance of inflammation (Drouard). Applied to a wound it destroyed the animal in twenty-two hours, and the body was every where in a healthy state[m]. Orfila[n] also found that it proved fatal in a few hours when applied to wounds. The only symptoms mentioned are dulness, loss of appetite, and sometimes purging. Inflammation of the mucous membrane of the stomach and rectum was found after death.

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[1] De Candolle, *Phys. Vég.* 1335.

γ. *On Man.*—In *very small doses* it has no sensible operation on the body, though it occasionally ameliorates certain diseases, such as epilepsy and ague: in these cases it has been denominated an antispasmodic and tonic. The local action on the alimentary tube is that of an astringent. Dr. Elliotson[o] has known a patient to take it for three years, for a particular kind of diarrhœa, without any constitutional effect. I have administered six grains thrice a day for several weeks, in an old dysentery, without any other obvious effect than slight nausea and amelioration of the disease for which it was given. In *larger doses* it is a safe and useful emetic, acting very speedily, and without exciting any great disorder of the general system. In *excessive doses* it becomes a poison, producing inflammation of the alimentary canal, and disordering the functions of the nervous system, as noticed when describing the action of the cupreous preparations generally. In a case mentioned by Dr. Percival[p], two drachms proved fatal; the patient was violently convulsed. In a more recent case[q] there were vomiting and insensibility, but no convulsions or purging: the child died in four hours.

Its topical action is stimulant, astringent, styptic, and caustic. Its causticity depends on its union, either as a neutral or basic salt, with one or more of the constituents of the tissues. Thus it combines with albumen to form a pale bluish green compound, which produces with caustic potash a violet-coloured solution[r]. According to Lassaigne[s] the bluish white precipitate which sulphate of copper occasions in a solution of albumen, is composed of *albumen* 90·1, and *sulphate of copper* 9·9.

USES.—Where speedy vomiting without much nausea is required, as in cases of narcotic poisoning, sulphate of copper is a tolerably sure and valuable *emetic.* It has also been used, with success, to provoke vomiting in croup, and thereby to promote the expulsion of the false membrane[t].

As an *astringent* it has been used with great benefit in chronic diarrhœa and dysentery[u]. It often succeeds where the ordinary vegetable astringents fail. It should be given in doses of from half a grain to two or more grains twice or thrice a day, in combination with opium. I have employed it with most excellent effects in the old diarrhœas of infants, in doses of $\frac{1}{12}$ of a grain. The largest dose I have given to an adult is six grains, as above mentioned. It is also used as an astringent to check excessive secretion from the bronchial and urino-genital mucous membranes. Dr. Wright[v] found it serviceable in dropsy.

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[m] Duncan, in Christison *on Poisons*, 432.
[n] *Toxicol. Gén.*
[o] *Lond. Med. Gaz.* xii. 557.
[p] *Transactions of the London College of Physicians*, iii. 88.
[q] *Lond. Med. Gaz.* xviii. 624 & 742.
[r] Dr. C. G. Mitscherlich, *Brit. Ann. of Med.* i. 751 and 817, and ii. 51.
[s] *Journal de Chim. Méd.* t. vi. 11e Séries.
[t] *Brit. and For. Med. Rev.* i. 568.
[u] Elliotson, *Lond. Med. Gaz.* viii. 378, and xii. 577; also *Med. Chir. Trans.* xiii. 451.

As a *tonic* or *antispasmodic* it has been given in intermittent diseases, as the ague; and in some maladies of the nervous system (epilepsy and chorea). In epilepsy it has recently been strongly recommended by Dr. F. Hawkins[w].

As a *topical* agent, it is often employed in substance as an application to ulcers, either for the purpose of repressing excessive soft and spongy granulations, commonly denominated "proud flesh," or of hastening the process of cicatrization: and for either of these purposes it is one of the best agents we can employ. Solutions of it are frequently applied to mucous membranes, to diminish excessive secretion: thus to the conjunctiva, in chronic ophthalmia, and to the mucous lining of the vagina or urethra, in discharges from these parts. In superficial ulcerations of the mucous membranes (especially of the mouth) one or two applications of the sulphate of copper, in substance, are generally sufficient to heal them.

As a *styptic* a solution of this salt is sometimes used to repress hemorrhages from a number of small vessels. Rademacher applied with good effect brandy impregnated with sulphate of copper in a case of alopecia, or baldness, which occurred in a young man; but it failed in the hands of Dr. T. J. Todd[x].

ADMINISTRATION.—The dose of it, as an *emetic*, is from three or four grains to fifteen; as an *astringent*, or *tonic*, from a quarter of a grain to one, two, or more grains, given so as not to occasion vomiting. Solutions used for external purposes vary considerably in their strength in different cases, but usually from one or two grains to eight or twelve, dissolved in an ounce of water, are employed.

ANTIDOTES.—Vide *Cuprum*.

3. AMMO'NIÆ CU'PRO-SUL'PHAS.—CUPRO-SULPHATE OF AMMONIA.

(Cupri Ammonio-Sulphas, *L.*—Cuprum Ammoniatum, *E. D.*)

HISTORY.—Boerhaave was acquainted with an ammoniacal solution of copper. In 1757 Weissman gave imperfect directions for its preparation. In 1799 Acoluth published a better process. Dr. Cullen introduced this substance into practice in this country. It is usually called *Ammoniated Copper*, or *Ammoniuret of Copper* (*Cupri Ammoniaretum*).

PREPARATION.—All the British Colleges give directions for its preparation.

The *London College* orders of Sulphate of Copper, ℥j.; Sesquicarbonate of Ammonia, ℥iss. Rub them together until Carbonic Acid ceases to evolve; then dry the Ammonio-sulphate of Copper, wrapped in bibulous paper, in the air.

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[v] *Lond. Med. Journ.* i. and x.

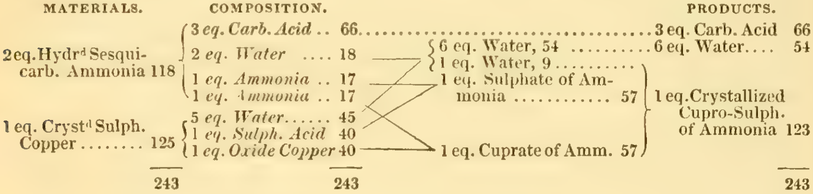
[w] *Lond. Med. Gaz.* viii. 183.

[x] *Cyclop. of Pract. Med.* i. 52.

The directions of the *Edinburgh College* are essentially similar; with the addition that the product is to be preserved "in closely-stoppered bottles."

The *Dublin College* employs of Sulphate of Copper, *two parts;* Carbonate of Ammonia, *three parts.*

The *theory* of the process is imperfectly understood. The proportions of ingredients employed are about two equivalents of sulphate and three and one-fifth equivalents of sesquicarbonate. When rubbed together, these salts give out part of their water of crystallization, by which the mass becomes moist; and, at the same time, a portion of carbonic acid of the sesquicarbonate escapes, producing the effervescence alluded to; and the compound becomes of a deep azure-blue colour. This colour is probably owing to cuprate of ammonia; for oxide of copper with caustic ammonia forms a similarly-coloured liquid. If this notion be correct, the decomposition may be thus explained:—Two equivalents or 118 parts of hydrated sesquicarbonate of ammonia react on one equivalent or 125 parts of crystallized sulphate of copper, and produce one equivalent or 57 parts of sulphate of ammonia, seven equivalents or 63 parts of water, and three equivalents or 66 parts of carbonic acid. The cuprate and sulphate of ammonia with one equivalent of water represent the crystallized cupro-sulphate of ammonia (*Cuprum ammoniacale* of some authors).



PROPERTIES.—It has a deep azure-blue colour, a styptic metallic taste, and an ammoniacal odour. It reacts on vegetable colours as an alkali: thus it reddens turmeric, and restores the blue colour of litmus, which has been reddened by an acid. By exposure to the air, ammonia is evolved, and a green powder is left, composed of sulphate of ammonia and carbonate of copper. To prevent this, therefore, it should be preserved in a well-stoppered bottle. It is soluble in water; but unless excess of sesquicarbonate of ammonia be present, the solution, when much diluted, lets fall a subsulphate of copper. Cupro-sulphate of ammonia crystallizes in large, right rhombic prisms, which Dr. Kane[y] considers to be macles.

Characteristics.—Dissolved in water it forms a green precipitate (*arsenite of copper*) with a solution of arsenious acid. When heated, all its constituents are dissipated, save the oxide of copper. Boiled with caustic potash a solution of sulphate of potash is obtained, the hydrated oxide of copper is thrown down, and ammonia is disengaged. Sulphuric acid may be recognised in the solution by the barytic salts.

By heat it is converted into oxide of copper, evolving ammonia. Dissolved in water, it changes the colour of turmeric, and solution of arsenious acid renders it of a green colour. *Ph. Lond.*

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[y] *Elements of Chemistry,* p. 833. Dublin, 1841.

Composition.—The essential part of this compound is the cupro-sulphate of ammonia. This, in the crystalline state, has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Brandes.*
Oxide of Copper	1	40	32·52	34·00	33·017
Ammonia	2	34	27·64	26·40	21·410
Sulphuric Acid	1	40	32·52	32·25	31·753
Water	1	9	7·32	7·35	13·358
Cryst^{d} Cupro-sulphate of Ammonia	1	123	100·00	100·00	99·538

Ammoniated Copper of the pharmacopœias usually contains some undecomposed sesquicarbonate (bicarbonate ?) of ammonia, and probably some sulphate (subsulphate ?) of copper.

Physiological Effects.—Its action is, for the most part, similar to sulphate of copper. Wibmer[z] examined its effects on horses and dogs. Four grains dissolved in water, and injected into the veins, killed a dog. The respiration and circulation were quickened by it. In some cases vomiting and purging were produced; weakness, tremblings, and paralysis, indicated its action on the nervous system. Its general effects on man are like those of sulphate of copper, but it is thought to be less disposed to occasion nausea and vomiting. An over-dose, however, readily acts as an emetic. Its action is probably somewhat more stimulant to the general system than the sulphate. It is employed in medicine as a tonic and antispasmodic.

Uses.—*Internally* it has been principally employed in chronic spasmodic affections; such as epilepsy, chorea, hysteria, spasmodic asthma, and cramp of the stomach. In epilepsy it has been much esteemed, and was found useful by Dr. Cullen[a], and other accurate observers; but, like all other remedies for this disease, it frequently fails. It has also been used in ague and dropsy. As a *topical* remedy, a solution of it has been employed as an injection in gonorrhœa and leucorrhœa; and as a collyrium to remove opacity of the cornea.

Administration.—It may be administered internally in doses of from half a grain gradually increased to five or more grains. It is usually exhibited in the form of pill; rarely in that of solution.

1. **PILULÆ CUPRI AMMONIATI**, E. *Pills of Ammoniated Copper.* (Ammoniated copper in fine powder, *one part;* Bread crumb, *six parts;* Solution of Carbonate of Ammonia, *a sufficiency.* Beat them into a proper mass; and divide it into pills, containing each half a grain of ammoniated copper). Dose from one to five or six pills in the before-mentioned cases.

2. **LIQUOR CUPRI AMMONIO-SULPHATIS**, L.; *Cupri Ammoniati Solutio*, E.; *Cupri Ammoniati Aqua*, D.; *Solution of Ammoniated Copper; Aqua Sapphirina.* (Ammonio-sulphate of Copper, ʒj.; Distilled Water, Oj. Dissolve the Ammonio-sulphate of Copper in the water, and strain. *L. E.*—The *Dublin College* uses of Ammoniated Copper, *one part;* Distilled Water, *one hundred parts*). This solution is ap-

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[z] *Wirk. d. Arzneim.* ii. 256

[a] *Treat. on Mat. Med.*

plied to indolent ulcers as a stimulant and detergent; and, when diluted, to the eye, to remove slight specks of the cornea.

4. CU'PRI SUBACE'TAS, *D.*—SUBACETATE OF COPPER.

(Ærugo; Diacetas Cupri impura, *L.*—Ærugo; Commercial Diacetate of Copper, *E.*)

History.—Hippocrates employed *Verdigris*, which he terms χαλκοῦ ἰὸς, or *Rust of Copper*, in diseases of the eyes, and as an astringent in hæmorrhoids[b]. Theophrastus[c], Dioscorides[d], and Pliny[e], describe the method of procuring it. The Romans called it *Ærugo*. It is frequently termed *Diacetate of Copper;* but this name is objectionable, since verdigris frequently occurs as a *Subsesquiacetate* mixed with the *Trisacetate*. I prefer the less precise, though more accurate term, *Subacetate of Copper*.

Preparation.—At Montpelier it is thus made:—The refuse of grapes is allowed to ferment with sour wine, and is then laid in alternate strata with plates of copper: acetous fermentation takes place, and the metal becomes oxidized by the combined influence of the air and acid. In about fifteen days the plates are covered with the acetate of copper: they are then wetted, and exposed for a month to the air: the acetate absorbs the water, and uniting with more oxide of copper, forms a subacetate, which is scraped off, and packed in leathern sacks for exportation. At Grenoble verdigris is obtained by sprinkling plates of copper with ready-made vinegar[f].

In this country it is prepared by exposing thin plates of copper to the action of acetic acid: the method now practised consists in alternating plates of copper with pieces of woollen cloth steeped in acetic acid: they gradually become corroded, and superficially covered with verdigris, which is from time to time removed, and the operation repeated, as long as the plate lasts[g]. French verdigris is imported in sacks, weighing from 25 to 30 pounds.

Properties.—It occurs in masses or in powder. One variety is of a pale bluish green colour; another is blue. Its taste is astringent and metallic; its odour is somewhat similar to, though more disagreeable, than acetic acid. It is insoluble in alcohol. Water resolves it into a soluble acetate and an insoluble trisacetate.

Characteristics.—When digested with strong sulphuric acid, it evolves acetic acid, which is readily distinguished by its odour. Heated in a glass tube it gives out acetic acid: the residue contains metallic copper. If verdigris be boiled in distilled water a solution is obtained, which is known to contain copper by its colour, and by the before-mentioned tests for its cupreous compounds (*vide* p. 774).

Composition.—The blue verdigris is a hydrated diacetate of copper. Verdigris with a greenish tint consists af the subsesquiacetate and the trisacetate[h]. The composition of these salts is as follows:—

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[b] *Opera*, Ed. Fæs. 635, 636, and 894.
[c] *De Lapidibus.*
[d] Lib. v. cap. xci.
[e] *Hist. Nat.* xxxiv.
[f] Dumas, *Traité de Chim.* v. 169.
[g] Brande's *Manual of Chemistry.*
[h] Berzelius, *Traité de Chimie*, iv. 347 and 349.

	DIACETATE,			SUBSESQUIACETATE,			TRISACETATE.		
	Atoms.	*Eq.Wt.*	*Per Ct.*	*Atoms.*	*Eq.Wt.*	*Per Ct.*	*Atoms.*	*Eq.Wt.*	*Per Ct.*
Oxide of copper	2	80	43·24	1½	60	43·48	3	120	63·5
Acetic Acid	1	51	27·57	1	51	36·96	1	51	27·0
Water	6	54	29·19	3	27	19·56	2	18	9·5
	1	185	100·00	1	138	100·00	1	189	100·0

PURITY.—The following are the characters of its purity given by the London and Edinburgh Colleges :—

May be partly dissolved in water, and is almost entirely soluble either in ammonia, or with the assistance of heat, in diluted sulphuric acid. *Ph. Lond.*

It is dissolved in a great measure by muriatic acid, not above five per cent. of impurity being left. *Ph. Edinb.*

Chalk and sulphate of copper are employed to adulterate verdigris. The first effervesces with the mineral acids. The characteristics of the second have been before pointed out (p. 776).

PHYSIOLOGICAL EFFECTS.—The action of verdigris on the system is very similar to that of the other preparations of copper: thus, taken in small and repeated doses, it acts on the nervous system, and is called tonic and antispasmodic; in larger doses it acts as an emetic; and, in excessive doses, is a powerful poison, producing both gastro-enteritis (indicated by vomiting, purging, and pain), and an affection of the nervous system (marked by insensibility, convulsions, and even tetanus).

USES.—Verdigris, when taken into the stomach, being variable and dangerous in its operation, is never administered internally. It was formerly employed in obstinate syphilis, when mercurials failed.

The *powder* is sometimes employed as an escharotic. It is sprinkled over foul and indolent ulcers, or, when mixed with savin, is applied to destroy venereal warts. When used for the latter purpose it rarely fails.

1. **CUPRI SUBACETAS PRÆPARATUM**, D.; *Prepared Verdigris.* (Let the Subacetate of Copper be triturated into powder, and let the finest parts be separated by the mode directed for the preparation of chalk). The object of this process is to obtain a very fine powder. The water, however, effects a chemical change on the verdigris, and converts it into a soluble acetate and an insoluble trisacetate.

2. **LINIMENTUM ÆRUGINIS**, L. *Oxymel Cupri Subacetatis*, D. *Mel Ægyptiacum; Unguentum Ægyptiacum; Oxymel Æruginis.* (Verdigris, powdered, ℥j.; Vinegar [distilled, *Dubl.*] f℥vij.; Clarified Honey, ℥xiv. Dissolve the verdigris in the vinegar, and strain the solution through linen; afterwards, the honey being added, boil down to a proper consistence).—Stimulant, detergent, and slightly escharotic. It is applied by means of a camel's-hair pencil to venereal ulcers of the throat, as well as to other indolent ulcers. Diluted with water it is employed as a gargle.

3. **UNGUENTUM CUPRI SUBACETATIS**, D.; *Unguentum Æruginis*, E. (Prepared Verdigris, ℥ss.; Olive Oil, ℥j.; Ointment of White Resin, lbj. M. Resinous ointment, ℥xv.; Verdigris, in fine powder, ℥j. M. *Ph. Ed.*) Stimulant and mildly escharotic. It is used as an application to foul

ulcers, in ophthalmia tarsi, as a cure for the obstinate forms of ringworm, and as an application to corns.

ANTIDOTES.—Vide *Cuprum*.

5. CU′PRI ACE′TAS, *D.*—ACETATE OF COPPER.

This salt is commonly, though very improperly, termed *Distilled* or *Crystallized Verdigris*, and is met with in the shops crystallized on sticks. It is usually prepared by dissolving common verdigris in acetic acid, and crystallizing. The crystals are oblique rhombic prisms. They consist of one equivalent of oxide of copper, one equivalent of acetic acid, and one equivalent of water. This salt is completely soluble in water, by which it is distinguished from common verdigris. In most other properties it agrees with the latter. It is included in the list of the materia medica of the Dublin Pharmacopœia, but for what reason I cannot understand, since it is never used in medicine. The bluish white precipitate obtained by adding a solution of the neutral acetate of copper to a solution of albumen, consists of *albumen* 90·81, and *deuto-acetate of copper* 9·19. It is soluble in excess of solution of either acetate of copper or of albumen[i].

ORDER XXIII.—BISMUTH AND ITS COMPOUNDS.

1. BISMU′THUM, *L. E. D.*—BISMUTH.

HISTORY.—This metal is first mentioned by Agricola, in 1529. It has been termed *Marcasita*, *Tectum Argenti*, or, by the Germans, *Wismuth*. "The old miners called it Wismuth," says Matthesius, "because it blooms as a beautiful meadow *(Wiesematte)*, on which variegated flowers of all kinds are glittering[j]."

NATURAL HISTORY.—Bismuth occurs only in the mineral kingdom. It is found in Cornwall, Saxony, Bohemia, &c. It is met with in the metallic state nearly pure (*Native Bismuth*), and in combination with sulphur and with oxygen.

PREPARATION.—It is chiefly obtained from native bismuth by melting the metal out of its gangue.

PROPERTIES.—It is a reddish white metal, without taste or smell, composed of brilliant broad plates, and readily crystallizable in cubes or regular octohedrons. Its sp. gr. is 9·83 to 9·88. It is moderately hard, brittle, pulverizable, fusible at 476° F. When strongly heated in the air it takes fire, and burns with a faint blue flame, emitting a yellow smoke (the oxide). In close vessels it may be volatilized. Its equivalent is 72.

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[i] Lassaigne, *Journ. de Chim. Méd.* t. vi. 11e Sér. p. 305.

[j] Schwartze, *Pharm. Tabellen.*

Characteristics.—It is distinguished by its brittleness (see p. 786), its ready fusibility, its solubility in nitric acid, and by the characters of the nitric solution, which throws down a white precipitate on the addition of water, and a black one when hydrosulphuric acid or the hydrosulphates are added to it.

PURITY. — Copper may be detected by precipitating the nitric solution with ammonia; the supernatant liquor is blue if copper be present.

It is dissolved by diluted nitric acid; when subnitrate of bismuth is precipitated from this solution by ammonia, the liquor is free from colour. Its specific gravity is 9·8. *Ph. Lond.*

Its powder is entirely soluble in nitric acid with the aid of heat; and the solution is colourless or nearly so, and deposits a white powder when much diluted with cold water. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS AND USES.—In the metallic state, bismuth is inert. Its only use is in the preparation of the trisnitrate.

2. BISMU'THI TRISNI'TRAS, *L.*—TRISNITRATE OF BISMUTH.

(Bismuthum album, *E.*—Bismuthi Subnitras, *D.*)

HISTORY.—This compound was first prepared by Lemery. It has had various appellations, such as *Pearl White, Magistery of Bismuth* (also a name for submuriate of bismuth), *Spanish White, Subnitrate* or *Tetarto-nitrate of bismuth.*

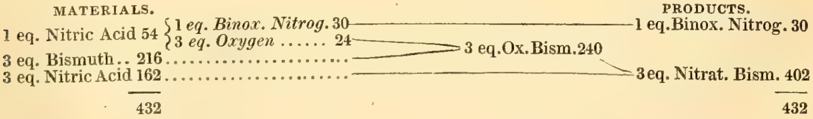
PREPARATION.—All the British Colleges give directions for the preparation of this salt.

The *London College* orders of Bismuth, ℥j.; Nitric Acid, f℥iss.; Distilled Water, Oiij. Mix a fluidounce of the water with the Nitric Acid, and dissolve the Bismuth in them; then pour off the solution. To this add the rest of the water, and set by that the powder may subside. Afterwards, the supernatant liquor being poured off, wash the Trisnitrate of Bismuth with distilled water, and dry it with a gentle heat.

The process of the *Edinburgh College* is essentially similar. The precipitate [the Trisnitrate] is directed to be collected on a calico filter, washed quickly with distilled water, and dried in a dark place.

The *Dublin College* directs it to be prepared with Bismuth reduced to powder, *seven parts;* Diluted Nitric Acid, *twenty parts;* Distilled Water, *one hundred parts.*

In the first part of this process we obtain a nitrate of bismuth by the re-action of three equivalents or 216 parts of bismuth, on four equivalents or 216 parts of nitric acid. One equivalent or 30 parts of binoxide of nitrogen are evolved, and three equivalents or 402 parts of nitrate of bismuth formed.



When nitrate of bismuth is mixed with water, two bismuthic salts are produced; a soluble supersalt (*ternitrate*), and an insoluble subsalt (*trisnitrate*).

MATERIALS.		PRODUCTS.
1 eq. Nitrate Bismuth = 134		1 eq. Ternitrate Bismuth = 242
3 eq. Nitrate Bismuth = 402	*2 eq. Nitric Acid* .... 108 *1 eq. Nitric Acid* .... 54 *3 eq. Oxide Bismuth* = 240	1 eq. Trisnitrate Bismuth = 294
536		536

PROPERTIES.—It is a dull white, inodorous, tasteless pulverulent substance, which, when examined by a magnifier, is found to consist of very fine silky acicular crystals. It is nearly insoluble in water, but is readily dissolved by nitric acid. By exposure to light it becomes greyish.

Characteristics. — Hydrosulphuric acid, or the hydrosulphates, blacken it, by forming the sulphuret of bismuth. It dissolves in nitric acid without effervescence. Heated on charcoal by the blowpipe flame it gives out nitrous acid (or its elements), and yields the yellow oxide of bismuth; and, by a continuance of the heat, the oxide is reduced, globules of metallic bismuth being obtained, which may be readily distinguished from globules of lead by their brittleness; for, when struck sharply by a hammer on an anvil, they fly to pieces: from antimony they are distinguished by their solubility in nitric acid.

COMPOSITION.—Its composition, according to Mr. Phillips[k], is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*R. Phillips.*
Oxide of Bismuth	3	240	81·64	81·92
Nitric Acid	1	54	18·36	18·36
Trisnitrate of Bismuth	1	294	100·00	100·28

PURITY.—Its freedom from any carbonate (as of lead) is distinguished by its solution in nitric acid without effervescence. Diluted sulphuric acid added to the solution throws down a white precipitate, if lead be present.

It is soluble in nitric acid without effervescence. Diluted sulphuric acid being added to the solution, nothing is thrown down. *Ph. Lond.*

It forms a colourless solution with nitric acid and without effervescence: not subject to adulteration. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. α. *On Animals.*—It acts as a local irritant and caustic poison. Moreover it appears to exercise a specific influence over the lungs and nervous system[l].

β. *On Man.*—In *small doses* it acts locally as an astringent, diminishing secretion. On account of the frequent relief given by it in painful affections of the stomach, it is supposed to act on the nerves of this viscus as a sedative. It has also been denominated tonic and antispasmodic. Vogt[m] says, that when used as a cosmetic, it has produced a spasmodic trembling of the muscles of the face, ending in paralysis.

Large medicinal doses disorder the digestive organs, occasioning pain, vomiting, purging, &c.; and sometimes affecting the nervous system, and producing giddiness, insensibility, cramps of the extremities, &c.

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[k] *Phil. Mag.* Dec. 1830, p. 409.
[l] Orfila, *Toxicol. Gén.*
[m] *Pharmakodynamik*, i. 288, 2te Aufl.

The following is the only reported case of poisoning with it. A man took two drachms by mistake, and died therefrom on the ninth day. In addition to the usual symptoms of gastro-enteritis, there was a disordered condition of the nervous system, indicated by cramps of the hands and feet, disordered vision, and delirium. It is deserving also of remark, that there were difficulty of breathing, and salivation. Post-mortem examination showed inflammation throughout the alimentary canal; the spinal vessels were gorged with blood, particularly towards the cauda equina; there was fluid in the cerebral ventricles; and the inner surface of both ventricles of the heart was very red[n].

USE.—It has been principally employed in those chronic affections of the stomach which are unaccompanied by any organic disease, but which apparently depend on some disordered condition of the nerves of this viscus; and hence the efficacy of the remedy is referred to its supposed action on these parts. It has been particularly used and recommended to relieve gastrodynia and cramp of the stomach, to allay sickness and vomiting, and as a remedy for the waterbrash. It has also been administered in intermittent fever, in spasmodic asthma, &c. Hahnemann has recommended a portion to be introduced into a hollow tooth, to allay tooth-ache. I have used it, with advantage, in the form of ointment, applied to the septum nasi, in ulceration of this part, and as a local remedy in chronic skin diseases.

ADMINISTRATION.—The usual dose of this remedy is from five grains to a scruple. I seldom commence with less than a scruple of it for a dose, and have repeatedly exhibited half a drachm without the least inconvenience. It may be administered in the form of linctus or pill. The ointment which I have above referred to was composed of one drachm of the trisnitrate, and half an ounce of spermaceti ointment.

ANTIDOTES.—No chemical antidote is known. Emollient drinks should be administered, and the poison evacuated from the stomach as speedily as possible. The antiphlogistic plan is to be adopted, to obviate inflammation.

ORDER XXIV.—TIN.

STAN'NUM, *L. E. D.*—TIN.

HISTORY.—Tin has been known from the most remote periods of antiquity. It is mentioned by Moses[o] and by Homer[p]. The alchymists called it *Jove*, or *Jupiter*.

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[n] Christison's *Treatise on Poisons.*
[o] *Numbers*, xxxi. 22.
[p] *Iliad*, xi. 25.

Natural History.—It is peculiar to the mineral kingdom. It occurs in two states; as an oxide (the *Tin Stone* and *Wood Tin* of mineralogists), and as a sulphuret (*Tin Pyrites*). It is found in both states in Cornwall, which has long been celebrated for its tin works. The Phœnicians, who were perhaps the first people who carried on commerce by sea, traded with England and Spain for tin at least 1000 years before Christ.

Preparation.—In Cornwall, *Stream Tin* (a variety of *Tin Stone*) is smelted with charcoal or with culm, in a reverberatory furnace. The metal thus procured is subsequently made hot, and then let fall from a height, or is struck with a hammer, by which it splits into a number of irregular prisms, somewhat like a basalt pillar. This is called *Grain Tin*; of this there are two kinds, the *best* which is used for dyers,—and a second employed in the manufacture of tin-plate, and which is called *tin-plate grain*. *Mine Tin* (another variety of *Tin Stone*) is stamped, washed, roasted, afterwards smelted with Welsh culm and limestone, by which *Block Tin* is procured; the finest kind of which is called *Refined Tin*[q].

Besides the two varieties of tin just described, other kinds are met with in commerce. *Malacca Tin* occurs in quadrangular pyramids, with flattened bases. *Banca Tin* is met with in wedge-shaped pieces.

Properties.—In its massive form it is a yellowish-white metal, having a peculiar odour when rubbed or handled. Its sp. gr. is 7·29. It melts at 442° F. and at a white heat is volatilized. It is malleable, and forms *Sheet Tin* and *Tin Foil* (*Stannum foliatum*), but is sparingly ductile. Its equivalent is 58.

Characteristics.—Boiled in strong hydrochloric acid, we obtain a solution of protochloride of tin, which has the following characters:—Potash added to it causes a white precipitate, soluble in excess of the precipitant; hydrosulphuric acid produces a brown precipitate; and chloride of gold, a dark or black precipitate. If protochloride of tin be heated with nitric acid, we obtain a perchloride which causes a yellowish precipitate with hydrosulphuric acid.

The London and Edinburgh Colleges give the following characteristics of its purity:—

> Boiled with hydrochloric acid it is almost entirely dissolved. The solution is free from colour, but becomes purple on the addition of chloride of gold. What is precipitated by potash is white, and when added in excess it is redissolved. The specific gravity of tin is 7·29. *Ph. Lond.*
>
> When finely granulated, 100 grains are entirely converted into a white powder by three fluidrachms of nitric acid (*D.* 1380); and distilled water, boiled with this powder and filtered, is colourless, and precipitates but faintly, or not at all, with solution of sulphate of magnesia. *Ph. Edinb.*

Physiological Effects.—In the mass, tin has no influence on the body, except that arising from its form and weight. Powdered tin is not known to produce any disorder in the functions of the body. It appears, however, that acid, fatty, saline, and even albuminous substances, may occasion colic and vomiting by having remained for some time in tin vessels. Oxide of tin is poisonous, according to Orfila[r]; but Schubarth[s] found it inactive.

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[q] Mr. John Taylor, *Ann. Phil.* iii. 449.

USES.—Powdered tin has been employed with great success by various practitioners, as a vermifuge, particularly in tape-worm. Dr. Alston[t] explains its operation on mechanical principles: he supposes that the powder of tin gets betwixt the worms and the inner coat of the alimentary canal, and causes them to quit their hold, so that purgatives easily carry them away with the fæces. It has, however, been asserted that water in which tin has been boiled is anthelmintic, at least so says Pitcairn and Pietsch[u]; wine which has been digested in a tin vessel is also said to be noxious to worms. If these statements be true, the before-mentioned mechanical explanation is inadmissible. Some have, therefore, supposed that the efficacy must depend on the tin becoming oxidized in the alimentary canal; others have fancied that arsenic, which is frequently found in tin, is the active agent; while, lastly, some have imagined that the metal, by its action on the fluids of the canal, generated hydrogen, or hydrosulphuric acid, which destroyed these parasites.

Dr. D. Monro[v], Fothergill, and Richter, have used powdered tin in epilepsy produced by worms, and, as it is stated, with advantage.

ADMINISTRATION.—It is usually exhibited mixed with treacle: the dose commonly employed is one or two drachms, but Alston gave much larger quantities. His mode of employing it as a vermifuge was the following:—The patient was well purged with senna, and on the following morning *one ounce* of tin powder was given in four ounces of treacle: on each of the two following days half this quantity was taken, and then the patient again purged. Tin powder is much inferior to oil of turpentine as a remedy for tape-worm.

STANNI PULVIS, E. D. *Powder of Tin; Granulated Tin.* (The *Edinburgh College* gives the following directions for its preparation:—Melt tin in an iron vessel; pour it into an earthenware mortar heated a little above the melting point of the metal; triturate briskly as the metal cools, ceasing as soon as a considerable portion is pulverized; sift the product, and repeat the process with what remains in the sieve. —The *Dublin College* orders of the purest Tin, any required quantity. Liquefied by heat, let it be strongly agitated until it passes into a powder, which when cold is to be shaken through a sieve.)—Tin may be reduced to powder by shaking it when melted in a wooden box, the inside of which has been rubbed with chalk. The doses and uses have been above described.

Tin Filings (*Stanni Limatura* seu *Rasura Stanni*) have also been used in medicine.

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[r] *Toxicol. Gén.*
[s] Quoted by Dr. Christison, *Treat. on Poisons.*
[t] *Med. Essays,* v. 89, 92; also, *Lect. on Mat. Med.* i. 150.
[u] Quoted by Richter, *Ausf. Arzneim.* iv. 553.
[v] *Treat. on Med. and Pharm. Chem.* i. 289.

ORDER XXV.—LEAD AND ITS COMPOUNDS.

1. PLUM'BUM.—LEAD.

History.—This metal was known in the most remote ages of antiquity. It is mentioned by Moses[w]. The Greeks called it μόλιβδος; the alchymists, *Saturn*.

Natural History.—It is found both in the metallic state (*Native Lead*) and mineralized. It is met with combined with sulphur (*Galena*), with selenium, with chlorine (*Horn Lead*), with oxygen (*Native Minium*), and with oxygen and an acid, forming an oxy-salt (*Carbonate, Phosphate, Sulphate, Tungstate, Molybdate, Chromate, Arseniate*, and *Aluminate*.)

Preparation.—It is usually extracted from galena, which is roasted in reverberatory furnaces, by which it is converted into a mixture of sulphate and oxide of lead, and afterwards smelted with coal and lime; the first to abstract oxygen, the second to remove the sulphur.

Properties.—It has a bluish-gray colour and considerable brilliancy. It may be crystallized by cooling in four-sided pyramids. It is malleable, but not ductile. Its sp. gr. 11·35. It has a peculiar odour when handled. It fuses at 612° F. and at a red heat boils and evaporates. Its equivalent is 104. By exposure to the air it attracts, first oxygen, and then carbonic acid, so as to form carbonate of lead.

Pure distilled water has no action on lead[x], if the gases (as air and carbonic acid) be excluded; but if these be admitted, a thin crust of carbonate is soon formed. It is remarkable that the presence of most neutral salts—sulphate of soda and chloride of sodium, for example—impairs the corrosive action of air and water[y]. Hence, therefore, we can easily comprehend the reason why leaden cisterns and pipes do not more frequently give a metallic impregnation to water; and why rain-water is more apt than spring-water to become impregnated with lead. The latter, however, by long keeping in leaden vessels, may also become contaminated with lead.

Characteristics.—If lead be dissolved in nitric acid, we may easily recognise its presence in the solution by the following tests:—Alkalis, their carbonates, sulphuric acid and the sulphates, and ferrocyanide of potassium, produce white precipitates (which are respectively *hydrated oxide, carbonate, sulphate*, and *ferrocyanide of lead*); chromate of potash and iodide of potassium occasion yellow precipitates (*chromate and iodide of lead*); hydrosulphuric acid and the hydrosulphates form black precipitates (*sulphuret of lead*); lastly, a piece of zinc throws down metallic lead in an arborescent form.

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[w] Job. xix. 23, 24.

[x] For some observations on this subject see Mr. Taylor's memoir in the *Guy's Hospital Reports*, vol. iii.

[y] Christison, *Treatise on Poisons*.

The delicacy of these tests is, according to Devergie[z] as follows:—

	Degree of Dilution.
Sulphate of Soda	stops at 5,000
Iodide of Potassium	10,000
Ferrocyanide of Potassium	18,000
Potash	20,000
Carbonate of Soda or of Potash	60,000
Chromate of Potash	100,000
Hydrosulphuric Acid	500,000

PHYSIOLOGICAL EFFECTS. **1. Of Metallic Lead.**—I believe that so long as lead retains its metallic form it is inert. In a French journal[a] it is stated that three ounces and six drachms of this metal have been given to a dog without any obvious effects. As, however, it is a metal which is readily oxidated, it occasionally proves active when swallowed. An instance of this kind is mentioned by Paulini[b], in which colic was produced by swallowing a leaden bullet. Proust[c] says, that the alloy of lead and tin may be swallowed with impunity, in consequence of its being much less easily oxidated than the pure metal.

2. Of the Preparations of Lead. α. *On Vegetables.*—Marcet found the solution of acetate of lead injurious to plants; but Wiegmann declares it to be inert, and ascribes its inertness to the formation of an insoluble salt (carbonate) of lead by the carbonic acid of the roots of the plants.

β. *On Animals.*—The preparations of lead are, for the most part, energetic poisons. The *Sulphuret*, however, appears to be inactive, or nearly so; for Orfila[d] gave an ounce of it to dogs without observing any ill effects; four ounces have even been given to horses without any unpleasant results. The *Sulphate*, also, according to Orfila, is inactive. Our knowledge of the effects of the salts of lead on animals is derived from experiments made with the acetate, nitrate, and carbonate. The first two act as corrosives: all affect the nervous system, and occasion convulsions, palsy, and colica pictonum[e].

γ. *On Man.*—Mr. Braid[f] states that workmen who dig and pulverize the ore (*sulphuret of lead*), at the Lead Hills in Lanarkshire, never have the lead colic until they work at the smelting furnaces.

Most, if not all, the other preparations are more or less active; the effects and symptoms, however, vary with the dose.

In *small doses* these preparations act on the alimentary canal as astringents; checking secretion and causing constipation. These may be regarded as the local effects. When absorbed, the constitutional effects of lead are observed: the arteries become reduced in size and activity, for the pulse becomes slower and smaller; the temperature of the body is diminished; and sanguineous discharges, whether natural or artificial, are frequently checked, or even completely stopped. This constringing and sedative effect seems extended to the secreting and exhaling vessels; the discharges from the mucous membranes, the exhalation from the skin, and the urine, being diminished in quantity. Thus we observe dryness of the mouth and throat, thirst, greater solidity of the alvine evacuations, diminution of the bronchial secretion, and of cutaneous exhalation. From these circumstances it appears that the preparations of lead give rise to a contracted state of the coats of the blood-vessels (at least of the arteries). It is not at all improbable that the absorbent vessels are similarly affected. The wasting of the body produced by lead (*Tabes saturnina*, or *Tabes sicca*) may perhaps be referred to this constringing influence on the vessels.

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[z] *Méd. Lég.* ii. 779.

[a] *Journ. de Méd. de Leroux*, xxiii. 318.

[b] *Miscell. Nat. Cur. Dec.* ii. Ann. vi. App. p. 7, quoted by Voigtels, *Arzneimittellehre.*

[c] *Ann. de Chim.* lvii. 84.

[d] *Toxicol. Gén.*

[e] Christison, *Treat. on Poisons*, 506 et seq. 3d ed.

[f] Christison, *op. cit.* 518.

A remarkable effect on the human gums, produced by the absorption of lead, has been pointed out by Dr. Burton[g]. It consists in the formation of a narrow leaden-blue line, about the one-twentieth of an inch thick, which borders the edges of the gums attached to the necks of two or more teeth of either jaw. In every case of lead colic that has fallen under my care I have observed this line. Moreover, in several cases where sugar of lead, in full doses, has been given for many days continuously, I have noticed it; and in most of the cases it was accompanied by abdominal pain. On two patients not known to have been subjected to the influence of lead I have observed some faint indication of a similar line, without, however, any constitutional symptoms of lead poisoning. I have not observed this line in patients under the influence of mercury. In one instance mentioned by Dr. Burton, fifteen grains of acetate of lead, taken in four days, caused the blue line: in another this effect was not produced until the patient had taken one hundred and sixty grains in twenty-one days.

Salivation[h], turgidity of the gums[i], and a bluish colour of the saliva[j], are other effects ascribed to the influence of lead. "I do not wish to assert," observes Dr. Burton, "that salivation and turgidity of the gums are never produced by the internal operation of lead; but I venture to affirm they are rare occurrences, and not characteristic of its influence."

The bluish colour of the saliva, and the blue line on the gums, probably depend on the presence of sulphuret of lead, formed by the action of sulphuretted hydrogen, evolved by the lungs, on the lead contained in the salivary and buccal secretion; for I have observed that an alloy of mercury and silver, introduced into the hollow of a tooth, becomes coated in a few days with a black film of metallic sulphuret.

The long-continued use of the preparations of lead rarely fails to give evidence of its effect on the muscular and nervous systems, and which is manifested by a curious train of symptoms, commencing with colic, and terminating in palsy or apoplexy. *Lead* or *painter's colic*, (*colica pictonum*) is variable in its mode of attack; at one time commencing suddenly, and without any very marked premonitory symptoms, at another being preceded by dyspeptic symptoms—such as diminished appetite, with a painful and constipated state of the bowels, the fæces being very hard. During an attack, there is usually obstinate constipation, with acute pain, much increased at intervals; but sometimes a relaxed condition of the bowels has been met with. Merat[k] refers the continued pain to the small intestines, while the more violent and intermitting kind resides principally in the transverse portion of the colon. Pressure rarely increases, and very commonly relieves, the pain. Cases, however, do occur (and I have seen several) in which there is great tenderness of the bowels. The abdomen is strongly retracted, sinks in about the navel, and feels very hard. To these symptoms may be added vomiting, cramps of the lower extremities, hard and generally slow pulse, though sometimes it has been found frequent.

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[g] *Medico-Chirurgical Transactions*, 2d Series, vol. v. p. 63. Lond. 1840.

[h] Dr. Warren, *Medical Transactions*, vol. ii. p. 87.

[i] Dr. A. Thomson, *Elements of Materia Medica*, vol. ii. p. 66; and Laidlaw, in the *Lond. Med. Rep.* N.S. vi. 292.

[j] Dr. Christison, *Treatise on Poisons*, p. 514. 3d. ed.

De Haen and Merat, on examining the bodies of patients who have died affected with lead colic, found a contracted condition of the colon, and this was considered by the last-mentioned writer to indicate the seat of the disease. But Sir G. Baker, Andral[l], Louis, and Copland[m], have not, in some cases, found any alteration. Moreover, it would appear probable from Dr. Abercrombie's observations on ileus[n] that the empty and collapsed portion of the intestine was not the seat of the colic, but another part found in a state of distension,—for the collapsed or contracted state is the natural condition of healthy intestine when empty; while the distended portion is, in ordinary cases of ileus, the primary seat of the disease, the distension arising from a paralytic condition of the muscular fibres, whereby it is unable to contract and propel its contents onward. Now this view of the case is the more probable, since the action of lead on the muscular fibres of the intestine is doubtless of the same kind as that on the fibres of the voluntary muscles. Some have found intussusception, others have noticed marks of inflammation.

Lead colic is accompanied by the blue line on the gums above referred to; which, therefore, is an important aid in distinguishing this variety of colic from that which arises from other causes.

Another effect of poisoning by lead is an affection of the cerebro-spinal system, generally manifested by *paralysis*, but occasionally by giddiness, convulsions, and coma, and now and then by apoplexy. The palsy may occur without colic, or it may come on while the patient is suffering with it, but in general it succeeds colic. It is accompanied with the blue line on the gums above described. It may happen in both upper and lower extremities, though more frequently in the former; and it affects the extensor more than the flexor muscles, so that the hands are generally bent on the arms, which hang dangling by the side. Frequently pain is experienced in the paralyzed part, and sometimes in the region of the spine also. On examining the bodies of persons who have died with this disease, no lesion has hitherto been discovered in the spinal marrow. The muscles of the affected limb are observed to be wasted and very pale, and have sometimes the appearance of a white fibrous tissue.

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[k] *Traité de la Colique Metallique.*
[l] *Path. Anat.* by Townsend and West, ii. 140.
[m] *Dict. Pract. Med.* i. 366.
[n] *On Diseases of the Abdom. Viscera.*

In *very large doses*, some of the plumbeous preparations (the acetate, for example) act as irritant and caustic poisons; giving rise to the usual symptoms indicative of gastro-enteritis. However, none of them equal, in the intensity of the local action, the mercurial or even the cupreous compounds.

MODUS OPERANDI.—Tiedemann and Gmelin[o] found lead in the blood of the splenic, mesenteric, and hepatic veins of dogs killed by the acetate; they also found it in the contents of the stomach and intestines, but neither in the chyle nor the urine. Wibmer[p] detected it in the liver, muscles, and spinal cord.

The local or corrosive action of the soluble salts of lead depends on the affinity of these bodies for the organic constituents of the tissues (vide *Plumbi Acetas*).

The nervous system is specifically affected by lead. The paralysis of the voluntary muscles, the pain in the course of the spine, the occasional giddiness, coma, or apoplexy, seem to establish this. The colic as well as the astringent influence of lead over the coats of vessels are probably secondary effects of the action of lead over the nervous system.

The constitutional effects of lead may be produced in various ways: as, when taken with articles of food and drink into the stomach; when inhaled in the form of dust or vapour with the air; when applied to mucous membranes, ulcers, &c. Hence the persons most liable to these effects are those whose occupations bring them in contact with this metal; for example, painters, plumbers, roasters and smelters of lead, the manufacturers of the plumbeous preparations, glass-blowers, potters, lapidaries, &c.

Dr. Anthony Todd Thomson[q] is of opinion, that carbonate of lead is the only preparation of this metal that can produce colic: and though he has, I think clearly, shewn that lead colic more frequently arises from the carbonate than from any other salt of lead, he has, in my opinion, failed in proving that no other preparation of lead *can* produce it. Indeed, if his opinion were true, it would constitute an exception to the general effects of the metallic preparations; for we do not find that the specific effects of arsenic, or of mercury, or of copper, or of antimony, are produced by one preparation only: so that, *à priori*, analogy is against the opinion. Furthermore, it is well known that the vapour of the oxide of lead taken into the lungs may produce colic, and that the ingestion of the acetate, citrate, or tartrate of lead, is capable of exciting the same effect. Now Dr. Thomson explains these facts by assuming that the oxide of lead unites with carbonic acid in the lungs, and is thus converted into carbonate: and that the acetate, citrate, and tartrate, are decomposed in the alimentary canal, and converted into carbonates. But it appears to me to be much more simple and consistent with analogy, to admit that these preparations are of themselves capable of producing colic, than to assume that they undergo the changes here supposed. Moreover, in some instances in which colic was produced, it is unlikely that these changes would have occurred, owing to the excess of acid taken with the salt of lead.

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[o] *Vers. über d. Wege, auf welchen Subst. aus d. Mag. ins Blut. gelang.*
[p] Christison's *Treatise on Poisons*, 3d edit. p. 509.
[q] *Lond. Med. Gaz.* v. 538, and x. 689.

Uses.—The uses of the preparations of lead may be in part inferred from the foregoing account of their effects. These agents are employed when we wish to constringe the capillary vessels and to diminish their vital activity. Thus we administer them internally to check excessive secretion and exhalation, as in catarrhal affections of the mucous membranes of a chronic nature; in profuse secretion of pus; in sanguineous exhalations from the mucous membranes; and colliquative sweating. They have also been applied, in some instances with success, in certain chronic affections of the nervous system, as epilepsy; but the practice is altogether empirical, as we have no rational principles to guide us in using them. As topical remedies[r], we employ the preparations of lead to diminish vascular excitement, to allay preternatural heat, and to check excessive secretion. Thus we apply them to inflamed parts to promote resolution, and to ulcers and other secreting surfaces as astringents or desiccants. During the internal employment of lead, attention must be paid to the condition of the gums, stomach, and bowels, as we find traces of their injurious effects in these organs. The blue line on the gums has been noticed. Constipation is a very frequent result of the medicinal employment of lead. Loss of appetite, indigestion, and griping pains, are also often noticed. The tendency to colic is diminished, according to Dr. A. T. Thomson, by conjoining acetic acid.

Antidotes.—Poisoning by lead usually puts on one of three forms—*irritant poisoning*, *lead colic*, and *paralysis;* and the treatment varies with each.

In irritant poisoning administer diluents holding in solution some sulphate (as sulphate of soda, of magnesia, or of potash or alum), so that a sulphate of lead may be formed. If vomiting have not already come on, tickle the throat, and administer emetics of the sulphate of zinc or of copper, or the stomach-pump may be employed.

In lead colic the best remedy is alum (*vide* pp. 618 and 619). But in this country lead colic is frequently treated by the combined use of purgatives and anodynes, the purgatives being either castor oil or salts and senna, and the anodyne being opium. When the vomiting is very troublesome, and liquid medicines do not remain on the stomach, we may give the compound extract of colocynth, with opium, in the form of pill. In several cases in which the pulse was full and strong, the face flushed, and the tongue furred and dry, I have used blood-letting with evident advantage. The sulphates have been recommended, as also mercury.

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[r] See Dr. Aikin's *Observations on the External Use of Preparations of Lead.* Lond. 1771.

In lead paralysis, nux vomica, and its active principles—strychnia and brucia are perhaps of all internal remedies most deserving of trial, because of their specific effect on the spinal marrow; and the chance of their success is, of course, much increased by the circumstance of there being no discoverable lesion of this portion of the nervous system. Mercury has been recommended by Dr. Clutterbuck. Various local measures have been tried, but without much benefit; for example, electricity and irritants (such as ammonia and cantharides).

2. PLUM'BI OX'YDUM.—OXIDE OF LEAD.

(Lithargyrum, *E.*—Plumbi Oxydum semivitreum, *D.*)

HISTORY.—The ancients were acquainted with oxide (*Protoxide*) of lead. Hippocrates[s] employed the semi-vitrified oxide (*Litharge*) λιθάργυρον). Dioscorides[t] and Pliny[u] both mention litharge: the latter calls it *Molybdæna.*

PREPARATION.—If melted lead be exposed to a current of air, it is rapidly oxidated and converted into the protoxide of this metal. The oxidated skimmings are denominated *Massicot.* This, when fused at a bright red heat, is separated from some metallic lead with which it was intermixed; the fused oxide forms, on solidifying, a brick-red mass, which readily separates into crystalline scales: these constitute *Litharge.*

Litharge is obtained as a secondary product in the cupellation of argentiferous lead. The alloy is melted on a porous vessel, called a *test* or *cupel*, and exposed to the blast of a bellows, by which the lead is oxidized, half vitrified, and driven off into hard masses of a scaly texture, and in that state is called *Litharge* or *Silver Stone*[v].

PROPERTIES.—Oxide of lead presents itself in several forms. One of these is yellow, and is termed *Massicot* (*Cerussa citrina*). When semivitrified (*Plumbi Oxydum semivitreum*), it is called *Litharge* (*Lithargyrum*), which occurs in the form of small yellow or reddish scales or flakes, and, according to its colour, is called *Gold* or *Silver Litharge* (*Lithargyrum aureum* [*Chrysitis*] seu *Argenteum* [*Argyritis*]). Gold Litharge owes its red tint to the presence of a portion of minium.

Oxide of lead is fusible, and at a very high temperature volatile. It is almost insoluble in water.

Characteristics.—Heated on charcoal by the blowpipe, it is readily reduced to the metallic state. It is blackened by hydrosulphuric acid, and completely dissolves in nitric acid. The characteristics of this solution have been already described (vide p. 790). The varieties of the oxide are distinguished by their physical peculiarities.

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[s] *De Morb. Mul.* ii.

[t] Lib. v. cap. cii.

[u] *Hist Nat.* xxxiv. 53.

[v] Watson's *Chem. Essays,* iii. 325, 6th ed.

COMPOSITION.—Oxide of lead is thus composed:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*	*Berthier.*
Lead	1	104	92·85	92·85	93·3
Oxygen	1	8	7·14	7·15	6·7
Oxide of Lead	1	112	99·99	100·00	100·0

PURITY.—It is not subject to adulteration.

Almost entirely soluble in dilute nitric acid. Its other properties are the same as those of carbonate of lead. *Ph. Lond.*

Fifty grains dissolve entirely, without effervescence; in a fluidounce and a half of pyroligneous acid; and the solution, precipitated by 53 grains of phosphate of soda, remains precipitable by more of the test. *Ph. Ed.*

The presence of a carbonate would be indicated by effervescence on the addition of acetic acid.

PHYSIOLOGICAL EFFECTS.—Inhaled in the form of vapour, or fine dust, it produces the before-mentioned constitutional effects of lead (*vide* p. 792).

The effects of this substance, when swallowed, are but little known. It possesses very slightly irritant properties. "The experimentalists of Lyons found litharge to be irritant in large doses of half an ounce[w]."

From its external use ill consequences have sometimes resulted.

USES.—Oxide of lead is never employed internally. Litharge is sometimes sprinkled over ulcers, as an astringent and desiccating substance. In pharmacy, it is used in the preparation of *Emplastrum Plumbi* (see p. 813), *Ceratum Saponis* (see p. 569), *Acetas Plumbi* (see p. 806), and *Liquor Plumbi Diacetatis* (see p. 810).

1. **PLUMBI OXYDUM HYDRATUM**, L. *Hydrated Oxide of Lead.* (Solution of Diacetate of Lead, Ovj.; Distilled Water, *Cong.* iij.; Solution of Potash, Ovj., or as much as may be sufficient to precipitate the oxide. Mix. Wash with water what is precipitated, until nothing alkaline remains). In this process the potash combines with acetic acid, and forms acetate of potash, which remains in solution, while the white hydrated oxide of lead is precipitated. According to Mitscherlich this compound consists of two equivalents or 224 parts of *oxide of lead*, and one equivalent or 9 parts of *water*: it is, there fore, a dihydrated oxide. It is soluble in a considerable excess of a solution of caustic potash.

What is used in preparing disulphate of quina should be totally dissolved by dilute nitric acid. Its remaining properties resemble those of the preceding. *Ph. Lond.*

It is directed, by the London College, to be employed in the preparation of *Quinæ Disulphas.*

2. **CALCIS PLUMBIS**; *Plumbite of Lime.*—This compound is employed as a *Hair Dye* (see p. 218).

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[w] Christison, *op. cit.* p. 509.

3. PLUM'BI OX'YDUM RU'BRUM:—RED OXIDE OF LEAD.

(Plumbi Oxidum rubrum, *E.*)

HISTORY.—It is doubtful whether the ancients were acquainted with this compound, as the substance which Pliny[x] called Minium was Cinnabar (see p. 762). He describes, however, an inferior kind, which he terms *Minium secundarium*[y], and which may be perhaps the red oxide of lead. Dioscorides[z] distinguished Minium from Cinnabar.

Besides *Minium* there are several other names for red oxide of lead. In commerce it is usually known as *Red Lead.* It is sometimes termed *Deutoxide of Lead.*

NATURAL HISTORY.—*Native Minium* is found in Yorkshire, Suabia, Siberia, and some other places.

PREPARATION.—Red lead is prepared by subjecting protoxide of lead (massicot or litharge) to the combined influence of heat and air. It absorbs oxygen and is converted into red lead. A heat of about 600° is necessary. The finest minium is procured by calcining the oxide of lead obtained from the carbonate[a].

PROPERTIES.—Red oxide of lead has a brilliant red colour. By heat it gives out oxygen gas, and is converted into the protoxide of lead.

Characteristics.—Before the blowpipe on charcoal it is converted into the yellow protoxide, and then into metallic lead. When digested in nitric acid, the nitrate of the protoxide is obtained in solution, while the insoluble brown or peroxide of lead remains. By the action of sulphurous acid on red lead, the white sulphate of the protoxide is obtained.

"Entirely soluble in highly-fuming nitrous acid; partially soluble in diluted nitric acid, a brown powder being left." *Ph. Ed.*

COMPOSITION.—The composition of real or pure red lead is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Lead	3	312	90·7
Oxygen	4	32	9·3
Red Lead	1	344	100·0

Or,	*Atoms.*	*Eq. Wt.*	*Per Cent.*	*Dumas.*
Protoxide	2	224	65·11	64·9
Peroxide	1	120	34·89	35·1
	1	344	100·00	100·0

Dumas[b] has shown that red lead of commerce is not uniform in composition; but consists of variable mixtures of real red lead with protoxide. His results have been confirmed by those of Mr. Phillips[c]. That real red lead is not a mere mixture of protoxide and peroxide is apparently shown by its colour as well as by the fact that it is not altered by heating it in a solution of acetate of lead, which is capable of dissolving free protoxide.

PHYSIOLOGICAL EFFECTS AND USES.—Its effects are similar to the protoxide of lead. It is but little employed in pharmacy. The

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[x] *Hist. Naturalis*, lib. xxxiii. cap. 40, ed. Valp.
[y] *Idem.*
[z] Lib. v. cap. 109.
[a] Graham, *Elements of Chemistry*, p. 589.
[b] *Ann. de Chim. et de Phys.* xlix. 398.
[c] *Phil. Mag.* N. S. iii. 125.

Edinburgh College directs it to be employed in the preparation of *Aqua Chlorinii* (see p. 230).

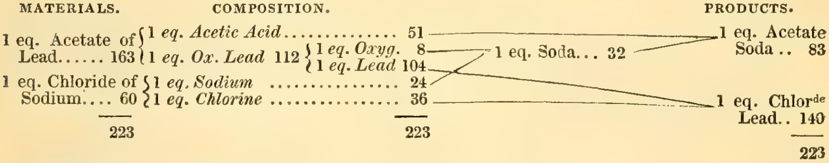
4. PLUM'BI CHLO'RIDUM, *L.*—CHLORIDE OF LEAD.

Natural History.—Chloride of lead is found native at Churchill, in the Mendip Hills of Somersetshire.

Preparation.—In the London Pharmacopœia this compound is directed to be prepared as follows:—

Take of Acetate of Lead, ℥xix.; Distilled Water, boiling, Oiij.; Chloride of Sodium, ℥vj. Dissolve the Acetate of Lead and Chloride of Sodium separately, the former in three pints of Distilled Water, and the latter in one pint of Distilled Water. Then the liquors being mixed together, wash what is precipitated with distilled water when it is cold, and dry it.

In this process one equivalent or 163 parts of dry acetate of lead are decomposed by one equivalent or 60 parts of chloride of sodium; by which one equivalent or 140 parts of chloride of lead are precipitated, and one equivalent or 83 parts of acetate of soda remain in solution.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Acetate of Lead...... 163
1 eq. Acetic Acid.............. 51
1 eq. Ox. Lead 112
1 eq. Oxyg. 8
1 eq. Lead 104
1 eq. Soda... 32
1 eq. Chloride of Sodium.... 60
1 eq. Sodium 24
1 eq. Chlorine 36
1 eq. Acetate Soda .. 83
1 eq. Chlorde Lead.. 140
223
223
223

Hydrochloric acid occasions the precipitation of more chloride of lead after the action of chloride of sodium is over; so that there must be some compound of lead in solution[d].

Properties.—It is a white crystalline powder *(Magisterium Saturni Crollii)*, soluble in thirty parts of cold or twenty-two parts of boiling water. When heated it fuses; and by cooling forms a semi-transparent horny-like mass, called *Horn Lead (Plumbum corneum)*.

Characteristics.—Its aqueous solution causes a white precipitate with nitrate of silver, soluble in ammonia but insoluble in nitric acid; hence it is shown to be a chloride. The solution is known to contain lead by the before-mentioned tests for this metal (vide p. 790).

Totally dissolved by boiling water, the chloride concreting almost entirely into crystals as it cools. On the addition of hydrosulphuric acid it becomes black, and by heat yellow. *Ph. Lond.*

Composition.—The following is its composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*J. Davy.*
Lead	1	104	74·3	74·22
Chlorine	1	36	25·7	25·78
Chloride of Lead	1	140	100·0	100·00

Use.—It is employed in the preparation of hydrochlorate of morphia.

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[d] Phillips, *Transl. of Pharm.* 4th ed.

5. PLUM'BI IO'DIDUM, *L. E.*—IODIDE OF LEAD.

History.—This compound was introduced into medicine by Cottereau and Verdé-Delisle.

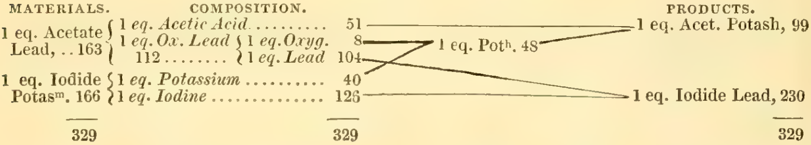
Preparation.—The London and Edinburgh Colleges give directions for the preparation of it.

The *London College* orders of Acetate of Lead, ℥ix.; Iodide of Potassium, ℥vij.; Distilled Water, *cong.* j. Dissolve the Acetate of Lead in six pints of the Water, and strain; and to these add the Iodide of Potassium first dissolved in two pints of the water. Wash what is precipitated, and dry it.

The reacting proportions of iodide of potassium and crystallized acetate of lead are 166 parts of the former and 190 parts of the latter. Hence the London College uses a larger proportion of iodide than is requisite, supposing the acetate to be neutral.

This excess is disadvantageous, since it retains a portion of the iodide of lead in solution. To prevent the formation of the pale yellow oxyiodide of lead, a little acetic acid should be added to the acetate of lead, before adding the iodide of potassium. The precipitate should be washed and dried.

By the mutual action of one equivalent or 163 parts of dry acetate of lead, and one equivalent or 166 parts of iodide of potassium, we obtain one equivalent or 230 parts of iodide of lead, and one equivalent or 99 parts of dry acetate of potash.


MATERIALS.
COMPOSITION.
PRODUCTS.
1 eq. Acetate Lead, . . 163
1 eq. Acetic Acid 51
1 eq. Ox. Lead 112 . . . .
1 eq. Oxyg. 8
1 eq. Lead 104
1 eq. Iodide Potas^m. 166
1 eq. Potassium 40
1 eq. Iodine 126
1 eq. Poth. 48
1 eq. Acet. Potash, 99
1 eq. Iodide Lead, 230
329
329
329

The *Edinburgh College* orders of Iodide of Potassium, and Nitrate of Lead, of each, ℥j.; Water, Oiss.; dissolve the salts separately, each in one-half of the water; add the solutions; collect the precipitate on a filter of linen or calico, and wash it with water. Boil the powder in three gallons of water acidulated with three fluidounces of pyroligneous acid. Let any undissolved matter subside, maintaining the temperature near the boiling point; and pour off the clear liquor, from which the iodide of lead will crystallize on cooling.

The reacting proportions are one atom or 166 parts of nitrate of lead, and one atom or 166 parts of iodide of potassium; or equal weights of the materials. The products are one equivalent or 230 parts of iodide of lead, and one equivalent or 102 parts of nitrate of potash.

For pharmaceutical purposes, especially for the preparation of ointments, the pulverulent iodide is preferable to the crystalline or scaly kind.

Properties.—It is a fine yellow powder, very sparingly soluble in cold water, but readily soluble in boiling water; from which it for the most part separates, as the solution cools, in the form of golden yellow, brilliant, small scales. It is fusible. It combines with the alkaline iodides, forming a class of double salts, called the (*plumbo-*

iodides (*iodo-plumbates*, Thomson). Caustic potash dissolves it, and forms a plumbo-iodide of potassium and plumbate of potash[e]. It is soluble in acetic acid and in alcohol.

Characteristics.—When heated, it first forms a yellow vapour (*iodide of lead*), and afterwards a violet vapour (*iodine*), leaving a residue (*lead*), which, when dissolved in nitric acid, gives all the characters of solution of lead (vide 790). Boiled with carbonate of potash, it forms carbonate of lead and iodide of potassium.

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Henry.*
Lead	1	104	45·21	45·1
Iodine	1	126	54·78	54·9
Iodide of Lead	1	230	99·99	100·0

PURITY.—It should be completely soluble in boiling water.

Totally dissolved by boiling water, and as it cools separates in shining yellow scales. It melts by heat, and the greater part is dissipated first in yellow, and afterwards in violet vapours. *Ph. Lond.*

Bright yellow: five grains are entirely soluble, with the aid of ebullition, in one fluidrachm of pyroligneous acid, diluted with a fluidounce and a half of distilled water; and golden crystals are abundantly deposited on cooling. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Twenty-four grains of iodide of lead were given to a cat at two doses, with an interval of four hours: the animal suffered violent colic, and died in three days; but no signs of irritation were observed after death[f]. Iodide of lead was given in doses of from gr. v. to ʒss. to a bull-dog: no effect was observed until the fifteenth day, when the animal refused food, and kept in the recumbent posture. He died on the eighteenth day, having swallowed altogether ten drachms and fifty grains of iodide. During the whole period, he had only three or four intestinal evacuations[g].

β. On Man.—Its effects on man have been imperfectly determined. It does not appear to act as an irritant when applied to the skin or ulcerated surfaces. Under the continued external and internal use of it, enlargements of the lymphatic glands have disappeared, from which we infer a specific influence over the glandular and lymphatic system. In some cases it appeared to occasion irritation of the stomach. I have seen constipation induced by it. After its medicinal use for several weeks I have not observed any blue line on the gums.

USES.—It has been principally employed to reduce the volume of indolent tumors, especially enlargements of the cervical, axillary, and mesenteric glands. In these cases it should be simultaneously administered internally and externally. I have also employed it in suspected incipient phthisis. I have used it in two cases of enlarged cervical glands, but without benefit. Velpeau[h] and others, however, have been more successful.

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[e] Dumas, *Traité de Chim.* iii. 379.
[f] Paton, *Journ. de Chim.* iii 41, 2nde Sér.
[g] Cogswell, *Essay on Iodine*, 143.

Administration.—The dose is three or four or more grains. Dr. O'Shaughnessy[i] says, ten-grain doses are easily borne, without the slightest annoyance. It is given in the form of pill.

UNGUENTUM PLUMBI IODIDI, L. (Iodide of Lead, ℥j.; Lard, ℥viij. M.)—This is applied, by way of friction, to scrofulous and other indolent swellings.

6. PLUM'BI CAR'BONAS, *L. E. D.*—CARBONATE OF LEAD.

History.—This substance was employed by Hippocrates[j], under the name of *ψιμμίϑιον*. Theophrastus[k] described the method of making it. Dioscorides[l] and Pliny[m] also mention it.

It has been known by several names, as *Psimmythium*, *Ceruse* (*Cerussa*), *Magistery of Lead* (*Magisterium Plumbi*), *White Lead*, *Flake White*, and *Subcarbonate of Lead*.

Natural History.—This salt is found native, crystallized, or massive, in Scotland, England, &c. It is called *White Lead Ore*.

Preparation.—Neutral carbonate of lead is obtained by adding an alkaline carbonate to a solution of acetate or nitrate of lead. Procured in this way it is deficient in *body*, owing to the transparency of the crystalline grains; and it is not, therefore, fitted for the use of the painter, who requires a carbonate having a dense and opaque body.

Within the last few years several patents have been taken out for new modes of preparation[n]. Some of the processes so patented have been subsequently abandoned, either because a profitable remmuneration could not be obtained by them; or because the quality of the product was inferior. I am informed that the white lead obtained by the old or Dutch process is superior, as an oil pigment, to that procured by most other methods.

"In the *Dutch process*, introduced into England about 1780, lead is cast into plates or bars, or into the form of stars, or circular gratings of six or eight inches in diameter, and from a quarter to half an inch in thickness: five or six of these are placed one above another in the upper part of a conical earthen vessel something like a garden-pot, in the bottom of which there is a little strong acetic acid. These pots are then arranged side by side, on the floor of an oblong brick chamber, and are imbedded in a mixture of new and spent tan (ground oak bark as used in the tan-yard). The first layer of pots is then covered with loose planks, and a second range of pots imbedded in tan is placed upon the former; and thus a stack is built up so as entirely to fill the chamber with alternate ranges of the pots containing the lead and acetic acid, surrounded by and imbedded in the tan. Several ranges of these stacks occupy each side of a covered building, each stack containing about 12,000 of the pots, and from 50 to 60 tons of lead. Soon after the stack is built up the tan gradually heats or ferments, and begins to exhale vapour, the temperature of the inner parts of the stack rising to 140° or 150°, or even higher. The acetic acid is slowly volatilized, and its vapour passing readily through the gratings or folds of lead, gradually corrodes the surface of the metal, upon which a crust of subacetate is successively formed and converted into carbonate, there being an abundant supply of carbonic acid furnished by the slow fermentative decomposition of the tanners' bark. In the course of from 4 to 6 weeks the process is completed, and now, on unpacking the stacks, the lead is found to have undergone a remarkable change: the form of the castings is retained, but they are converted, with considerable increase of bulk, into dense masses of carbonate of lead; this conversion is sometimes entire, at others it penetrates only to a certain depth, leaving a central skeleton as it were of metallic lead, the conversion being unequal in different parts of the stack, and varying in its perfection at different seasons, temperatures, and states of the atmosphere. The stacks are so managed that they are successively being built up and unpacked. The corroded and converted gratings, or cakes, are then passed through rollers, by which the carbonate of lead (white lead) is crushed and broken up, and the central core of metallic lead (blue lead), if any remain, is easily separated: the white lead is then transferred to the mills, where it is ground up into a thin paste with water, and is ultimately reduced, by the process of elutriation or successive washings and subsidences, to the state of an impalpable powder; it is then dried in wooden bowls, placed upon shelves in a highly-heated stove, and thus brought to the state of masses easily rubbed between the fingers into a fine powder, in which the microscope does not enable us to discern the slightest traces of crystalline character. If intended for the use of the painter, it is next submitted to grinding with linseed oil; and it is found that a hundred-weight of this white lead is formed into a proper consistence with 8 pounds of oil, whereas precipitated white lead requires 16 pounds of oil for the same purpose; the one covering the surface so much more perfectly, and having so much more body than the other. It is sometimes supposed in this process that the oxygen and carbonic acid required to form the carbonate of oxide of lead are derived from the decomposition of the acetic acid; but this is evidently not the case, for not more than 100 pounds of real acetic acid exist in the whole quantity of the diluted acid contained in the several pots of each stack; and in 100 pounds of acetic acid there are not more than 47 to 48 pounds of carbon, whereas 6740 pounds would be required to furnish the carbonic acid which should convert 50 tons of lead (the average weight of that metal in each stack) into carbonate of lead. There can be no doubt then that the carbon or carbonic acid must come from the tan, and that the oxygen is partly derived from the same source, and partly from the atmosphere: the principal action of the acetic acid therefore is to form successive portions of subacetate of lead, which are successively decomposed by the carbonic acid: the action is, however, of a very remarkable description, for even masses of lead, such as blocks of an inch or more thickness, are thus gradually converted through and through into carbonate, so that if due time is allowed there is no central remnant of metallic lead. The original texture of the lead is much concerned in the extent and rapidity of the conversion. Rolled or sheet lead will not answer, and the gratings, coils, and stars which are employed, are all of cast-lead. The purest metal is also required; for if it contain iron, the resulting white lead acquires a tawny hue, and if a trace of silver, it acquires a perceptible dinginess when it is subjected to the action of light." (Brande).

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[h] Lugol's *Essays*, by Dr. O'Shaughnessy, p. 206.

Lugol's *Essays*, p. 207.

De Morbis, lib. ii.

[k] *De Lapidibus*.

Lib. v. cap. ciii.

[m] *Hist. Nat.* lib. xxxiv.

[n] See *Repertory of Patent Inventions*; also Brande's *Manual of Chemistry*, 5th ed.; *Journal de Pharmacié*, t. xxvi. p. 772; and Ure's *Dict. of Arts*, art. *White Lead*.

PROPERTIES.—The form of the crystals of the native carbonate of lead is a right rhombic prism. Artificial carbonate is a heavy, snow-white, tasteless powder, or it occurs in white chalk-like masses. It is insoluble in water, but dissolves in caustic potash. When heated it gives out carbonic acid, and forms the yellow oxide.

Characteristics.—Heated before the blow-pipe, on charcoal, it yields metallic lead. It is blackened by hydrosulphuric acid. It dissolves in nitric acid with effervescence. The solution possesses the general characters of the plumbeous solutions already described (*vide* p. 790).

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Oxide of Lead	1	112	83·58	83·5
Carbonic Acid	1	22	16·42	16·5
Carbonate of Lead	1	134	100·00	100·0

Commercial white lead is not a neutral salt, but a mixture or combination of carbonate and hydrated oxide of lead in varying proportions [o].

PURITY.—Carbonate of lead of commerce is rarely pure. It is usually adulterated with earthy or metallic sulphates (as of lime, baryta, or lead). These are detected by their insolubility in diluted nitric acid. Chalk (which is by some used to adulterate it) may be detected as follows:—Dissolve the suspected substance in nitric acid, and precipitate the lead by hydrosulphuric acid. Boil and filter the solution, in which will be contained nitrate of lime (if chalk had been present), recognizable by oxalic acid or oxalate of ammonia (*vide* p. 578).

Dissolved with effervescence in dilute nitric acid. What is precipitated from the solution by potash is white, and is re-dissolved by excess of it: it becomes black on the addition of hydrosulphuric acid. It becomes yellow by heat, and, with the addition of charcoal, it is reduced to metallic lead. *Ph. Lond.*

It does not lose weight at a temperature of 212°: 68 grs. are entirely dissolved in 150 minims of acetic acid diluted with a fluidounce of distilled water; and the solution is not entirely precipitated by a solution of 60 grs. of phosphate of soda. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Its *local* effects are not very powerful: applied to ulcerated surfaces it acts as a desiccating and astringent substance: swallowed in large quantities it does not act as a local irritant, like the acetate. Its *constitutional* effects are similar to those of the other preparations of lead already described. It appears (see p. 794) that carbonate of lead more frequently produces colic than the acetate of lead—a circumstance which Dr. Christison thinks may be owing to the great obstinacy with which its impalpable powder adheres to moist membranous surfaces, and the consequent greater certainty of its ultimate absorption.

USES.—It is never administered internally.

Externally it is employed as a dusting powder in excoriations of children and lusty persons; but the practice is objectionable, on account of the danger of absorption. In one case, related by Kopp [p], a child was destroyed by it. An ointment or plaster of carbonate of lead has been known to give relief in some cases of neuralgia [q].

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[o] Mulder, *Pharmaceutisches Central-Blatt für* 1840, S. 100; and Richardson, in Graham's *Elements of Chemistry*, p. 591.

[p] Richter, *Ausf. Arzneim.* iv. 613.

[q] *Journ. de Pharm.* xx. 603.

UNGUENTUM PLUMBI CARBONATIS, *E. D.* *Ointment of Carbonate of Lead.* (Simple Ointment, ℥v.; Carbonate of Lead, ℥j. *E.*—Carbonate of Lead, reduced to very fine powder, ℥ij.; Ointment of White Wax, lbj. *D.* Mix.)—This ointment is valuable as a cooling and desiccating application to excoriated surfaces or burns.

7. PLUM′BI NI′TRAS, *E.*—NITRATE OF LEAD.

Preparation.—The Edinburgh College gives the following directions for its preparation:—

> Take of Litharge, ʒivss.; Diluted Nitric Acid, Oj. Dissolve the litharge to saturation with the aid of a gentle heat. Filter, and set the liquor aside to crystallize. Concentrate the residual liquid to obtain more crystals.

The nitric acid combines with the protoxide of lead to form the nitrate of this metal.

Properties.—This salt crystallizes in regular octohedrons or modifications of these. It is soluble in water and alcohol. Its solution is sweet and austere. The crystals loudly decrepitate by heat.

Characteristics.—When subjected to heat in a glass tube this salt evolves the reddish-brown vapour of nitrous acid. It possesses also the other characters of a nitrate which have been before stated (p. 289). It is known to be one of the plumbeous salts by the before-mentioned tests for these substances (p. 790).

Composition. — This salt is anhydrous. Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Döbereiner.*	*Berzelius.*
Oxide of Lead	1	112	67·47	67·6	67·2225
Nitric Acid	1	54	32·53	32·4	32·7775
Crystallized Nitrate of Lead	1	166	100·00	100·0	100·0000

Physiological Effects.—Its general effects are similar to those of the other soluble salts of lead. Its local action on the animal tissues depends on its affinity for albumen and fibrin. In a solution of albumen it forms a white precipitate, composed, according to Lassaigne[r], of *albumen*, 89·45, and *nitrate of lead*, 10·55. This precipitate is soluble in a great excess of albumen, as well as in solutions of ammonia and some neutral salts, as acetate of potash.

Uses.—The Edinburgh College employs it in the preparation of *Iodide of Lead.*

8. PLUM′BI ACE′TAS, *L. E. D.*—ACETATE OF LEAD.

History.—Raymond Lully and Isaac Hollandus were acquainted with this salt in the 13th century. It has been known by several appellations, as *Sugar of Lead* (*Saccharum Saturni*), *Acetated Ceruse* (*Cerussa acetata*), and *Superacetate of Lead* (*Plumbi Superacetas*).

Preparation.—Though directions are given in the British Pharmacopœias for its preparation, it is never made by the apothecary, but is procured from persons who manufacture it on a large scale.

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[r] *Journ. de Chim. Méd.* t. vi. 2nde Série.

The *London College* orders of Oxide of Lead, rubbed to powder, lbiv. and ℥ij.; Acetic Acid; Distilled Water, each Oiv. Mix the acid with the water, and add the oxide of lead to them, and, a gentle heat being applied, dissolve it; then strain. Lastly, evaporate the liquor, that crystals may be formed.

The *Edinburgh College* uses of Pyroligneous Acid (D. 1034) Oij.; Distilled Water, Oj.; Litharge, ℥xiv.

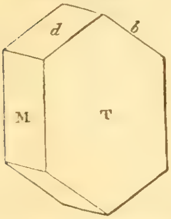
The *Dublin College* employs of Carbonate of Lead, named Ceruse, *any required quantity;* Distilled Vinegar, *ten times the weight of the Carbonate of Lead.*

In the above processes the protoxide of lead combines with acetic acid, and forms a definite compound. In the Dublin process carbonic acid is set free.

Acetate of lead is sometimes procured by partially immersing lead in crude acetic acid. The metal attracts oxygen from the air, and the oxide thus formed unites with the acid.

PROPERTIES.—The crystals of this salt belong to the oblique prismatic system. Their taste is sweetish and astringent. In a dry and warm atmosphere they slightly effloresce, and are apt to be decomposed by the carbonic acid of the air, and thus to become partially insoluble. When heated they fuse, give out their water of crystallization, and, at a higher temperature, are decomposed; yielding acetic acid, *Pyroacetic Spirit* (*Acetone*, $C^3 H^3 O$), carbonic acid, inflammable gas, and water: the residuum is a pyrophoric mixture of lead and charcoal. Acetate of lead is soluble in both water and alcohol. The aqueous solution feebly reddens litmus, though it communicates a green colour to the juice of violets. "A solution of the neutral acetate is partially decomposed by carbonic acid: a small quantity of carbonate of lead is precipitated, and a portion of acetic acid is set free, which protects the remaining solution from further change[s]."

FIG. 126.



Crystal of Acetate of Lead.

Characteristics.—When heated with sulphuric acid, the vapour of acetic acid is disengaged. Its solution is known to contain lead by the tests for this metal already mentioned (vide p. 790). If a small quantity of acetic acid be added to the solution, a current of carbonic acid occasions no precipitate. The ordinary acetate of the shops throws down a scanty white precipitate (*carbonate of lead*) with carbonic acid. When charred, it readily yields globules of metallic lead on the application of the blowpipe flame.

COMPOSITION.—The neutral acetate has the following composition:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*
Oxide of Lead	1	112	58·9	58·71
Acetic Acid	1	51	26·8	26·97
Water	3	27	14·3	14·32
Crystallized Acetate of Lead	1	190	100·0	100·00

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[s] Dumas, *Traité de Chim.* t. v. p. 173.

Purity.—It should be readily and completely soluble in water. Sulphuric acid, or sulphuretted hydrogen in excess, being added to the solution, to throw down the lead, the supernatant liquor should be completely volatilized by heat: any fixed residue is impurity.

Dissolved by distilled water. By carbonate of soda a white precipitate is thrown down from the solution, and by iodide of potassium a yellow one; by hydrosulphuric acid it is blackened. Sulphuric acid evolves acetic vapours. By heat it first fuses, and is afterwards reduced to metallic lead. *Ph. Lond.*

Entirely soluble in distilled water acidulated with acetic acid: forty-eight grains thus dissolved are not entirely precipitated by a solution of thirty grains of phosphate of soda. *Ph. Ed.*

Physiological Effects. *α. On Vegetables.*—(Vide p. 791.)

β. On Animals.—Orfila[t] found that in large doses the acetate of lead acted on dogs as an irritant, and caused vomiting, pain, and death. When the action was slower, and absorption took place, an affection of the nervous system was observed, marked by difficult progression, and in some cases convulsive movements. The mucous membrane lining the alimentary canal was found whitened (owing to the chemical influence of the poison), and, where the action was more prolonged, reddened. Injected into the veins, or applied to wounds, it affects the nervous system. Schloepfer[u] produced colica pictonum, paralysis, and convulsions, in dogs, by the repeated use of small doses. Dr. A. T. Thomson[v] gave successively, one, two, three, and six drachms to a dog without any ill effect.

γ. On Man.—Applied to ulcers, mucous membranes, or other secreting surfaces, it acts as a desiccative and astringent. It reacts chemically on the albumen of the secretions and of the living tissues, and forms therewith compounds which are for the most part insoluble in water and acids[w]. Hence the difficulty with which this salt becomes absorbed. Some of its compounds with organic substances are, however, rendered soluble in water by acids (as the acetic, hydrochloric, and lactic). In large quantities, acetate of lead taken into the stomach acts as an irritant, and causes symptoms of inflammation of the stomach, viz. vomiting, burning in the gullet and stomach, and tenderness at the pit of the stomach; but these are usually accompanied with colica pictonum, and are not unfrequently followed by convulsions, coma, or local palsy[x]. Ten grains taken daily for seven days caused tightness of the breast, metallic taste, constriction of the throat, debility, sallow countenance, slow respiration and circulation, turgid and tender gums, ptyalism, tightness and numbness in the fingers and toes, no nausea, pains of the stomach and abdomen, bowels confined[y]. The observations of Dr. A. T. Thomson and others (Van Swieten[z], Reynolds, Latham, Laidlaw, Daniell,

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[t] *Toxicol. Gén.*

[u] Quoted by Dr. Christison, p. 507.

[v] *Lond. Med. Gaz.* x. 691.

[w] Dr. C. G. Mitscherlich, *Brit. Ann. of Med.* i. 204.

[x] Christison, *Treat. on Poisons*, 3d edit. p. 512.—In a recent case an ounce of acetate of lead in solution, caused, in a young girl, collapse and syncope followed by vomiting and convulsions. Orfila detected lead in the urine (*Pharm. Trans.* No. vi. p. 119).

[y] Laidlaw, *Lond. Med. Repos.* N. S. vi. 292.

[z] *Commentaries*, vol. x. p. 236, Eng. ed. Van Swieten says colic was induced by the use of a drachm of lead in an emulsion every day for ten days.

Christison, &c.) have, however, shewn that injurious effects from the use of large doses are very rare. I have repeatedly given five grains three times a day for ten days, without inconvenience. This dose was taken for a fortnight [a]. The blue line on the gums (see p. 792) was then very distinct, and the patient complained of griping pains in the bowels. Dr. Christison has given eighteen grains daily for eight or ten days without any unpleasant symptoms whatever, except once or twice slight colic. During its employment the gums should be frequently examined, in order that the earliest appearance of the blue line, before referred to, may be detected. Whenever this salt gives rise to any obvious effects, they are those of the plumbeous preparations in general, and which have been already described (p. 791). Its medicinal action, therefore, is sedative and astringent.

USES.—Acetate of lead is administered *internally* to diminish the diameter of the capillary vessels, and lessen circulation, secretion, and exhalation. Thus, we employ it in profuse discharges from the mucous membranes; as from the lungs, alimentary canal, and even the urino-genital membrane. In the mild cholera, so common in this country towards the end of summer, I have found acetate of lead in combination with opium most efficacious where the chalk mixture failed. I have used this combination in a few cases of malignant cholera, and in one or two with apparent benefit. In colliquative diarrhœa and chronic dysentery it occasionally proves serviceable [b]. In phthisis it has been found beneficial, but only as a palliative; namely, to lessen the expectoration, check the night-sweats, or stop the harassing diarrhœa. Dr. Latham [c] speaks most favourably of the use of sugar of lead and opium in checking purulent or semipurulent expectoration. I have repeatedly seen it diminish expectoration, but I have generally found it fail in relieving the night-sweats, though Fouquier supposed it to possess a specific power of checking them: they are more frequently benefited by diluted sulphuric acid. In sanguineous exhalations from the mucous membranes, as epistaxis, hæmoptysis, and hæmatemesis, and in uterine hemorrhage, it is employed with the view of diminishing the calibre of the bleeding vessels, and thereby of stopping the discharge: and experience has fully established its utility [d]. It may be employed in both the active and passive states of hemorrhage. It is usually given in combination with opium. In bronchitis, with profuse secretion, it proves exceedingly valuable [e]. It has been employed also as a remedy for mercurial salivation [f]. It had been applied for this affection in the form of gargle by Sommé [g]. Unless care be taken to wash the mouth carefully after its use, it is apt to blacken the teeth. On the same principles that we administer it to check excessive mucous discharges, it has been employed to lessen the secretion of pus in extensive abscesses attended with hectic fever.

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[a] In the *Journ. de Chim. Méd.* (t. vi. 21^{e} Série, p. 97) a case is related of death from this salt. The patient, a boy of 15 years of age, affected with a phthisical malady, took from a ¼ gr. to grs. ii. four times a day, until he had taken 130 grs. without any ill effect. A month after he was seized with colic, which was followed by paralysis and death.

[b] See Dr. Burke, *On the good Effects of a mixture of Acetate of Lead and Tincture of Opium in the Dysentery which occurred in Dublin in* 1825, in the *Edinb. Med. and Surg. Journ.* vol. xxvi. p. 56.

[c] *Med. Trans. Coll. Phys.* v. 341.

[d] Reynolds, *Trans. of Coll. Phys. London*, iii. 217; Davies, *Med. and Phys. Journ.* Jan. 1808, p. 8; also, Mitchell, *ibid.* p. 69; and Latham, *op. cit.*

[e] Henderson, *Lond. Med. Gaz.* May 8, 1840.

[f] Daniell, *Lond. Med. Repos.* N. S. vi. 308.

[g] *Archiv. Gén. de Méd.* i. 483.

There are some other cases in which experience has shewn acetate of lead is occasionally serviceable, but in which we see no necessary connection between its obvious effects on the body and its remedial powers; as in epilepsy, chorea, intermittents, &c.

As a *topical* remedy, we use acetate of lead as a sedative, astringent, and desiccant. An aqueous solution of it is applied to inflamed parts, or to secreting surfaces, to diminish profuse discharges. Thus, we use it in phlegmonous inflammation, in ophthalmia, in ulcers with profuse discharges, in gonorrhœa, and gleet. In the sloughing and ulceration of the cornea which attend purulent and pustular ophthalmia, its use should be prohibited, as it forms a white compound which is deposited on the ulcer, to which it adheres tenaciously, and in the healing becomes permanently and indelibly imbedded in the structure of the cornea. The appearance produced by this cause cannot be mistaken: its chalky impervious opacity distinguishes it from the pearly semi-transparent structure of even the densest opacity produced by common ulceration[h]. The white compound consists of oxide [acetate?] of lead, animal matter, much carbonate of lead, traces of phosphate and chloride of the same metal[i].

Administration.—Acetate of lead may be administered internally in doses of one or two grains to eight or ten grains, repeated twice or thrice daily. Dr. A. T. Thomson advises its exhibition in diluted distilled vinegar, to prevent its change into carbonate, which renders it more apt to occasion colic. It is usually exhibited in the form of pill, frequently in combination with opium. Acetate of lead and opium re-act chemically on each other, and produce acetate of morphia and meconate, with a little sulphate, of lead. Experience, however, has fully established the therapeutic value of the combination. Sulphuric acid (as in infusion of roses), sulphates (as of magnesia, and soda, and alum), phosphates, and carbonates, should be prohibited. Sulphuric acid, the sulphates, and phosphates, render it inert: the carbonates facilitate the production of colica pictonum. Common (especially spring) water, which contains sulphates, carbonates, and chlorides, is incompatible with this salt. The liquor ammoniæ acetatis is incompatible with it, on account of the carbonic acid usually diffused through this solution.

1. CERATUM PLUMBI ACETATIS, *L.*; *Unguentum Plumbi Acetatis*, E. D.; *Unguentum Saturninum; Cerate of Sugar of Lead.* (Acetate of Lead, powdered, ʒij.; White Wax, ℥ij.; Olive Oil, f℥viij. *L.*—Simple Ointment, ℥xx.; Acetate of Lead, in fine powder, ℥j. *E.*—Ointment of White Wax, lbiss.; Acetate of Lead, ℥j. D. Mix).—An excellent soothing application to irritable ulcers, painful excoriations, and blistered surfaces.

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[h] Dr. Jacob, *Dublin Hosp. Rep.* v. 369: also, Velpeau., *Lond. Med. Gaz.* Oct. 5, 1839.

[i] Dr. Apjohn, *op. cit.* p. 402.

2. **PILULÆ PLUMBI OPIATÆ**, E. *Acetate of Lead and Opium Pills.* Acetate of Lead, *six parts;* Opium, *one part;* Conserve of Red Roses, *about one part.* Beat them into a proper mass, which is to be divided into four-grain pills.—This pill may be made also with twice the quantity of opium).—Each pill contains three grains of acetate of lead, and half a grain of opium. I have before stated that, notwithstanding a mutual decomposition is effected between acetate of lead and opium, the resulting compound is a most efficacious one. The Edinburgh College, therefore, has done wisely in countenancing the combination, but the permission to vary the strength of the pill is highly objectionable. In hæmoptysis, profuse secretion of bronchial mucus, obstinate diarrhœa, and dysentery, its effects are most valuable. Dose, one to three grains.

9. LI'QUOR PLUM'BI DIACETA'TIS, *L.*—SOLUTION OF DIACETATE OF LEAD.

(Plumbi Diacetatis Solutio, *E.*—Plumbi Subacetatis Liquor, *D.*)

History.—This compound was known to Basil Valentine in the fifteenth century. It owes its reputation, as a medicine, principally to the praises bestowed on it by M. Goulard[j], in the latter end of the last century. He called it *Extract of Saturn* (*Extractum Saturni*). It is frequently termed *Goulard's Extract.*

Preparation.—The following are the directions of the British Colleges for its preparation:—

The *London College* orders, of Acetate of Lead, lbij. and ℥iij.; Oxide of Lead, rubbed to powder, lbj. and ℥iv.; Water, Ovj. Boil them for half an hour, frequently stirring, and when the liquor is cold, add of distilled water as much as may be sufficient to measure with it six pints; lastly, strain [the solution].

The *Edinburgh College* employs, of Acetate of Lead, ʒvj. and ʒvj.; Litharge, in fine powder, ℥iv.; Water, Oiss.

The acetate of lead combines with an additional equivalent of oxide of lead to form the diacetate. This process yields an uniform product.

The *Dublin College* employs, of Litharge, *one part;* Distilled Vinegar, *twelve parts.* Boil together in a glass vessel until eleven parts of the fluid remain; then let the liquor rest, and when the impurities have subsided, let it be filtered.

In this process the acetic acid unites with the oxide of lead to form a subsalt. This method of preparation is objectionable, since the strength of the solution depends on the strength of the vinegar, which is subject to variation.

A Treatise on the Effects and various Preparations of Lead, particularly of the Extract of Saturn, for different Chirurgical Disorders, 2nd ed. Lond. 1770.

PROPERTIES.—It is a transparent and colourless liquid. Prepared according to the London Pharmacopœia, its specific gravity is 1·260: according to the Dublin Pharmacopœia, it is 1·118. Its taste is sweet and astringent. By evaporation it yields crystals of the diacetate of lead, which, according to Dr. Barker, are flat rhomboidal prisms, with dihedral summits.

Characteristics.—The presence of lead and acetic acid in this solution may be known by the tests before mentioned (p. 790) for acetate of lead.

From the neutral acetate it is distinguished by the copious precipitate which it produces with carbonic acid, as well as with mucilage. Solution of the diacetate of lead forms a precipitate with most vegetable colouring matters.

COMPOSITION.—This liquid is an aqueous solution of the diacetate of lead. The solid hydrated diacetate has, according to Dr. Thomson, the following composition :—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Oxide of Lead	2	224	61·37
Acetic Acid	1	51	13·97
Water	10	90	24·66
Solid Hydrated Diacetate of Lead	1	365	100·00

PURITY.—When this compound has been prepared with common vinegar, it has a brown colour.

Its sp. gr. is 1·260. Its other properties are similar to those of the last preparation. *Ph. Lond.*

A copious precipitate is gradually formed when the breath is propelled through it by means of a tube. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—Its effects are analogous to the acetate. Its chemical action on the living tissues depends on its affinity for albumen and fibrine. In a solution of albumen it occasions a white precipitate, composed of albumen and diacetate of lead. According to Lassaigne[k], the precipitate caused in an albuminous liquor by the trisacetate of lead consists of *albumen* 71·67, and *trisacetate of lead* 28·33. This precipitate is soluble in an excess of the solution of the trisacetate, as well as in concentrated solutions of several salts (as acetate and nitrate of potash), and of caustic ammonia. Dr. A. T. Thomson[l] asserts, from his experiments on animals, that the diacetate has more tendency to cause colic than the neutral acetate, because it is more readily converted into carbonate of lead. It is employed in medicine as a local astringent and sedative. Paralysis is said to have resulted from its external use.

USES.—It is employed, when diluted, to promote the resolution of external inflammation, to check profuse discharges from suppurating, ulcerated, and mucous surfaces, and to alleviate local pains. Thus it is applied to parts affected with either phlegmonous or erysipelatous inflammation, to whitloes, to inflamed tendons, aponeuroses, or absorbent glands; in ophthalmia, to contusions, sprains, burns, wounds (whether incised or lacerated), to blistered surfaces, ulcers, abscesses, &c.

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[k] *Journ. de Chim. Méd.* t. vi. 2e Série, p. 299.

[l] *Lond. Med. Gaz.* vol. v. p. 538; vol. x. p. 693.

It is said to have proved successful, when administered internally, in hydrophobia.

ADMINISTRATION.—It is employed diluted with water, added to poultices, or mixed with fatty matters, and applied as an ointment.

1. **LIQUOR PLUMBI DIACETATIS DILUTUS**, *L.* *Plumbi Subacetatis Liquor compositus*, D. (Solution of Diacetate of Lead, fʒiss.; Distilled Water, Oj.; Proof Spirit, ℥ij. M.)—This preparation is an imitation of the *Water of Saturn*, or *Vegeto-Mineral Water* of Goulard. It is commonly termed, in the shops, *Goulard Water*. It should be transparent and colourless; but when prepared with common water it is more or less milky, owing to the formation of carbonate, sulphate, and chloride of lead. The small quantity of spirit employed can be of no service. The quantity of the solution of diacetate of lead employed in making Goulard water is much too small; it should be, at least, three times, and in some cases I have used six times as much. I have never seen any ill effects from its use, though it is said to have become absorbed in some cases. The same objection applies to the use of this compound as to that of the neutral acetate, in ulceration of the cornea (*vide* p. 809).

Goulard water is used as a cooling, sedative, and astringent wash in the cases already enumerated for the Goulard's extract. A poultice, composed of crumb of bread, boiled in Goulard water, is sometimes a very useful application to phlegmons, painful wounds, irritable ulcers, &c. &c.

2. **CERATUM PLUMBI COMPOSITUM**, *L.* (Solution of Diacetate of Lead, f℥iij.; Wax, ℥iv.; Olive Oil, Oss.; Camphor, ʒss. Mix the melted Wax with eight fluidounces of the Oil; then remove them from the fire, and, when first they begin to thicken, gradually add the solution of Diacetate of Lead, and stir them constantly with a spatula until they cool; lastly, with these mix the Camphor dissolved in the rest of the oil.) This is the *Cerate of Saturn* of M. Goulard, and is commonly called *Goulard's Cerate*. It is employed as a dressing to wounds and ulcers, for the purpose of allaying irritation and appeasing pain. With the same views it is also applied to excoriated surfaces, burns, scalds, blistered surfaces, and irritable cutaneous affections. Opium is sometimes advantageously combined with it.

3. **CERATUM SAPONIS**, *L.*—This contains a subacetate of lead. It has been before described (p. 569).

10. EMPLAS'TRUM PLUM'BI, *L.*—PLASTER OF LEAD.

(Emplastrum Lithargyri, *E. D.*)

History. — This compound was known to the ancients: both Pliny[m] and Celsus[n] gave a formula for a plaster used by the Roman surgeons, which is almost identical with that for the officinal plaster of lead. It is commonly sold in the shops as *Diachylon* or *Diachylum.*

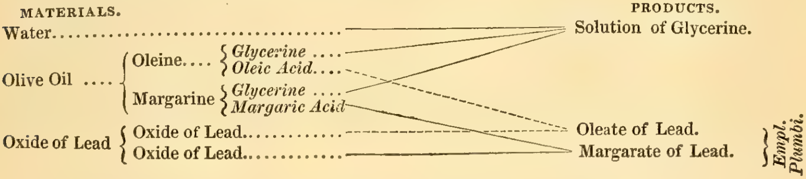
Preparation.—The following are the directions of the British Colleges for its preparation:—

The *London College* orders of Oxide of Lead, rubbed to very fine powder, lbvj.; Olive Oil, *Cong.* j.; Water, Oij. Boil them together with a slow fire, constantly stirring, until the Oil and Oxide of Lead unite into the consistence of a plaster; but it will be proper to add a little boiling water, if nearly the whole of that which was used in the beginning should be evaporated before the end of the boiling.

The *Edinburgh College* orders of Litharge, in fine powder, ℥v.; Olive Oil, f℥xij.; Water, f℥iij. Mix them; boil and stir constantly till the oil and litharge unite, replacing the water if it evaporate too far.

The process of the *Dublin College* is similar to that of the London College.

Olive Oil is a compound of Oleine (*Oleate of Glycerine*) and Margarine (*Margarate of Glycerine*). When subjected to heat with litharge and some water, the oxide of lead combines with the oleic and margaric acids, and sets free the glycerine, which remains dissolved in the water. The mixture of oleate and margarate of lead constitutes *emplastrum plumbi*[o]. The water employed in this process serves two purposes: it moderates the heat and facilitates the union of the acids with the oxide of lead.



Properties.—It is met with in the shops in cylindrical rolls, of a greyish or yellowish-white colour, brittle when cold, but softening and ultimately fusing by heat. It is insoluble in water, and nearly so in alcohol. It has no taste, but a slight though peculiar odour.

Characteristics.—When heated it fuses, then decomposes, gives out inflammable gas, and leaves a carbonaceous residue, which, when heated in a close vessel, yields globules of lead. Ether dissolves oleate but not margarate of lead.

Composition.—Lead plaster consists of *Oxide of Lead, Oleic Acid,* and *Margaric Acid.* The proportions have not been precisely ascertained. The two compounds which oleic and margaric acids form with oxide of lead are probably basic salts.

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[m] *Hist. Nat.* xxxiv. 53.
[n] *De Medicina*, lib. v. cap. xix..
[o] See p. 564 for an account of Saponification.

Effects and Uses.—This plaster is employed in surgery, on account of its adhesiveness and the mildness of its local action; for it rarely excites irritation. It is used to keep the edges of wounds together in persons with delicate skins. Spread on calico it forms a good *strapping* for giving support and causing pressure in ulcers of the leg,—a most successful mode of treating them, and for which we are indebted to Mr. Baynton.

In pharmacy it serves as a basis for various other plasters.

1. EMPLASTRUM RESINÆ, L.; *Emplastrum Resinosum*, E.; *Emplastrum Lithargyri cum Resinâ*, D.; *Resin Plaster*. (Resin, lbss. [℥j. *E.*]; Lead Plaster, lbiij. [ʒv. *E.*; lbiijss. *D*]. To the plaster of lead, melted with a slow fire, add the Resin, powdered, and mix).—This is the common *Adhesive Plaster* (*Emplastrum Adhæsivum*), and is kept in the shops ready spread. It is employed to retain the lips of wounds in contact, as in cuts, surgical operations, &c. It is more adhesive than lead plaster, but at the same time somewhat more irritating, and occasionally causes excoriation. It is employed as a *strapping* for dressing ulcers on Baynton's principles.

2. EMPLASTRUM SAPONIS, L. E. D. This contains lead plaster, (see p. 569).

3. UNGUENTUM PLUMBI COMPOSITUM, L. (Prepared Chalk, ʒviij.; Distilled Vinegar, f℥vj.; Plaster of Lead, lbiij.; Olive Oil, Oj. Mix the chalk with the vinegar; and, when the effervescence has ceased, add gradually the solution to the plaster and oil melted with a slow fire, and stir constantly until they are cooled).—By the action of the acetic acid on the chalk, an acetate of lime is procured, and carbonic acid evolved, and the acetate of lime is then mixed with lead plaster and oil. This compound is an imitation of *Kirkland's Neutral Cerate*, used as a dressing to indolent ulcers. It is employed by Mr. Higginbottom[p], under the name of *Neutral Ointment*, as a defence for ulcers after the application of nitrate of silver.

Order XXVI.—ZINC AND ITS COMPOUNDS.

1. ZIN'CUM, *L.E.D.*—ZINC.

History.—Although the ancients were acquainted with the method of converting copper into brass by means of an ore of zinc, yet we have no positive evidence that they were acquainted with metallic zinc, one of the constituents of this alloy[q] Albertus Magnus, who died in 1280, is the first writer who expressly mentions this metal[r].

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[p] *Essay on the Use of Nitrate of Silver*, 2nd ed. p. 119.

[q] Beckmann, in his *History of Inventions and Discoveries*, vol. iii. p. 71, has given a good account of the history of zinc.

[r] An anonymous reviewer (*British and Foreign Medical Review*. vol. viii. p. 361), in commenting on the above paragraph, observes, that a passage in Strabo authorises the belief that the ancients did know this metal in its separate state, and that it is the *false silver* (ψευδάργυρον) of that ancient geographer.

It has had various appellations, such as *Contrefeyn*, *Golden Marcasite*, *Indian Tin* (*Stannum Indicum*), *Spiaulter*, *Speltre* or *Spelter* (*Speltrum*).

Natural History.—It occurs only in the mineral kingdom. It is found in the form of Oxide (*Red Zinc*), of Sulphuret (*Blende* or *Black Jack*), of Carbonate (*Calamine*), of Sulphate (*White Vitriol*), of Silicate (*Electric Calamine*), and Aluminate (*Automalite* or *Gahnite*).

Preparation.—Zinc is usually procured from the native sulphuret or carbonate of that metal. It may also be obtained from the silicate.

Both the sulphuret and carbonate are roasted: by this process the sulphur of the sulphuret is transformed into sulphurous acid, which escapes, and the zinc is oxidized; while the carbonate loses carbonic acid and water. The oxide is then mixed with some carbonaceous substance and submitted to heat, by which the metal is reduced and vaporized. Sometimes the reduction is effected in a covered earthen crucible, the bottom of which is perforated by an iron tube, which terminates over a vessel of water situated in an apartment below the furnace. The gaseous products and zinc escape by this tube; and the latter is condensed in the water. This is called *distillatio per decensum.* In Silesia, however, *distillatio per ascensum* is employed[s].

The zinc used in this country is principally imported in ingots and plates from Silesia, by way of Hamburg, Antwerp, Dantzic, &c.

Properties.—It is a bluish-white metal, of considerable lustre. It crystallizes in four-sided prisms and needles; its texture is lamellated and crystalline. Its sp. gr. is from 6·8 to 7·2. At common temperature it is tough; from 212° to 300° it is ductile and malleable, and may be readily rolled into thin leaves (*Sheet Zinc*); at 400° it is so brittle that it may be reduced to powder. It readily fuses, and, at a white heat, may be volatilized.

Characteristics.—It is soluble in dilute sulphuric acid, with the evolution of hydrogen gas. Ferrocyanide of potassium forms, in this solution, a gelatinous white precipitate (*ferrocyanide of zinc*): if iron be present the precipitate is bluish-white. If the liquid be neutral, hydrosulphuric acid and the soluble hydrosulphates also occasion a white or yellowish-white precipitate (*hydrated sulphuret of zinc*). Alkalis and their carbonates likewise throw down white precipitates: that occasioned by the alkalis is soluble in excess of alkali. The delicacy of these tests is, according to Devergie[t], as follows:—

		Degree of Dilution.
Ferrocyanide of Potassium	stops at ..	4,000
Ammonia	„ ..	6,000
Potash, or Carbonate of Ammonia	„ ..	8,000
Carbonate of Potash, or Hydrosulphate of Ammonia	„ ..	10,000
Hydrosulphuric Acid	„ ..	15,000

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[s] Dumas, *Traité de Chimie*, t. iv. p. 82.

[t] *Méd. Lég.* ii. 787.

Purity.—The zinc of commerce is never pure. It always contains iron and carbon, and not unfrequently traces of arsenicum. By the action of diluted sulphuric acid the zinc and the iron are dissolved, while the arsenicum, when present, escapes in the form of arseniuretted hydrogen gas. A black matter remains undissolved, which has a carbonaceous appearance, but contains iron.

Almost entirely dissolved by diluted sulphuric acid. The solution is free from colour. Its other properties as above [see *Zinci sulphas*]. The specific gravity is 6·86. *Ph. Lond.*

It dissolves in a great measure in diluted sulphuric acid, leaving only a scanty grayish-black residuum: this solution presents the characters just given [see *Zinci sulphas*] for the solution of sulphate of zinc. *Ph. Ed.*

Physiological Effects.—In the *metallic* state it is inert. The *compounds of zinc* are somewhat analogous in their action on the system to those of copper, silver, and bismuth, but are much less energetic. They act topically, according to their degree of concentration, as desiccants, astringents, irritants, and caustics. Taken internally, they excite, more or less readily, nausea and vomiting, and in large doses operate as irritant and caustic poisons. They exercise a specific influence over the nervous system, though this is much less obvious than in the preparations of the other metals just referred to. The stupor and inactivity, mentioned by Orfila[u], as being produced by the sulphate, are evidence of the affection of the nervous system. The antispasmodic power evinced by zinc, in certain diseases, can only be explained by referring it to the action of this metal on the nervous centres.

Uses.—As *topical* agents we employ the compounds of zinc as caustics, astringents, and desiccants. Thus the chloride is used as a caustic; the sulphate and acetate as astringents; and the oxide and carbonate as desiccants.

Internally, the compounds of zinc are administered in large doses to excite vomiting; in smaller doses as tonics and antispasmodics in intermittent diseases and chronic affections of the nervous system.

2. ZIN'CI OX'YDUM, *L. D.*—OXIDE OF ZINC.

(Zinci Oxidum, *E.*)

History.—The oxide was first prepared by Hellot in 1735. It has received various names, some of them of a fantastic nature; as *Nihil album*, *Lana philosophica*, *Pompholyx*, *Flowers* or *Calx of Zinc* (*Flores* seu *Calx Zinci*).

Natural History.—Oxide of zinc is found in America, mixed or combined with the sesquioxide of manganese, and constituting the *Red Oxide of Zinc* of the mineralogist. It is also found in various localities, in combination with carbonic, sulphuric, or silicic acid.

Preparation.—All the British Colleges give directions for the preparation of this compound.

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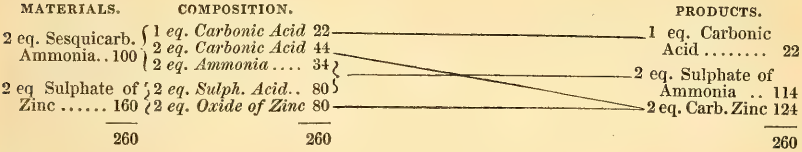
[u] *Toxicol. Gén.*

The *London College* orders of Sulphate of Zinc, lbj.; Sesquicarbonate of Ammonia, ℥viss.; Distilled Water, *Cong.* iij. Dissolve the Sulphate of Zinc and Sesquicarbonate of Ammonia, separately, in twelve pints of the distilled Water, and strain; then mix. Wash what is precipitated frequently with water; and, lastly, burn it for two hours in a strong fire.

The *Edinburgh College* employs of Sulphate of Zinc, ℥xij.; Carbonate of Ammonia, ℥vj. The process is otherwise the same as that of the London College.

In these processes double decomposition takes place; sulphate of ammonia is formed in solution, and carbonate of zinc precipitates. A portion of the carbonic acid of the sesquicarbonate of ammonia escapes.



The carbonate of zinc is decomposed by the subsequent ignition, and the carbonic acid expelled, leaving the oxide.

The *Dublin College* directs Oxide of Zinc to be prepared as follows:—Take of Zinc, broken into small fragments, any required quantity. Let portions of the metal be thrown at separate intervals of time into a crucible heated to whiteness and of sufficient depth; its mouth inclining somewhat toward the door of the furnace; and after the injection of each piece of zinc, let another crucible be inverted over that which receives the metal, but loosely, that the air may not be excluded: let the sublimed light powder and the whitest part of it be preserved for use.

In this process the metal attracts oxygen from the air, and is thereby converted into oxide of zinc.

A manufacturing chemist who prepares oxide of zinc (so called) informs me that he obtains it from a solution of chloride of zinc, which he procures from the workers of palladium. This liquid is boiled with small pieces of zinc and some caustic soda, to get rid of the iron; and to the clear liquor is then added a solution of carbonate of soda (soda ash), by which the white carbonate of zinc is precipitated. This is washed, dried, and sold as oxide of zinc.

Properties.—The form of the crystallized native oxide of zinc (containing the oxides of iron and manganese) is a right rhombic prism.

The artificial oxide of the Pharmacopœia is a white, or, when ignited, yellowish-white, tasteless, odourless powder. It is fusible, forming a yellow glass, and at a white heat is volatilized. When heated with charcoal it is readily reduced. It is insoluble in water, but readily dissolves in most acids and in alkalis. It forms two classes of salts: one (the *zincic salts*), in which it is the base; a second (*zincates*), in which it acts the part of an acid.

Characteristics.—It dissolves in dilute sulphuric acid. The characteristics of the solution have been already detailed (p. 815).

COMPOSITION.—Oxide of zinc has the following composition :—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Proust.*	*Berzelius.*
Zinc	1	32	80	80	80·1
Oxygen	1	8	20	20	19·9
Oxide of Zinc	1	40	100	100	100·0

PURITY.—Pure oxide of zinc is completely and readily soluble in diluted sulphuric, nitric, or hydrochloric acid, without effervescence. The substance met with in the shops under the name of oxide of zinc is in reality a carbonate of this metal, and, therefore, effervesces on the addition of an acid. The solution obtained by dissolving the oxide in any of the above acids yields a precipitate, on the addition of caustic ammonia or potash, which should be completely soluble in an excess of the precipitant.

If the substance sold as oxide of zinc have been prepared by adding a caustic alkali to a solution of sulphate of zinc, it will be found to be in reality a subsulphate instead of an oxide; and its solution in nitric acid yields traces of containing sulphuric acid when tested with a salt of baryta.

Oxide of cadmium has been sometimes found in it, and was once mistaken for arsenious acid[v]. Iron and manganese[w] are sometimes present in oxide of zinc, and communicate a yellow tinge to it. The oxide is,—

> White: tasteless: entirely soluble in diluted nitric acid without effervescence: this solution is not affected by nitrate of baryta, but gives with ammonia a white precipitate entirely soluble in an excess of the test. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.*—Orfila[x] gave from three to six drachms of it to small and weak dogs: they were attacked with vomitings, without suffering much.

β. On Man.—Applied to ulcerated or other secreting surfaces, it acts as a desiccant and astringent substance. On account of its insolubility, the absorption of it must be very slow. Taken into the stomach in large doses, it acts as a slight irritant, and provokes vomiting, and sometimes purging. It is said to have also caused occasional giddiness and temporary inebriation. In small doses it may be taken for a considerable period without causing any obvious effects. Sometimes, under its employment, certain affections of the nervous system (as epilepsy, chorea, &c.) subside; from which we infer that it exercises some specific influence over this system; and it is, therefore, termed tonic, antispasmodic, and sedative. But the nature of its influence is not very obvious, and is inferred rather from analogy than observation. By long-continued use it acts as a slow poison, and produces *tabes sicca*. A gentleman, for the cure of epilepsy, took daily, at an average, twenty grains of oxide till he had consumed 3246 grains, which must have taken him about five months. At the end of this time he was found of a pale, earthy hue, wasted away, and almost idiotical: his tongue was thickly coated, the bowels were constipated, the inferior extremities cold and œdematous, the abdomen tumid, the superior extremities cold and shrivelled, and their skin dry, like parchment; the pulse was about sixty, thready, and scarcely perceptible. Under the use of purgatives, a light nutritive diet, with tonic and diuretic medicines, he rapidly recovered, but he remained subject to epileptic attacks[y].

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[v] Thomson's *Hist. of Chem.* ii. 219.
[w] Liebig
[x] *Toxicol. Gén.*

Uses.—*Internally* it has been commended in some spasmodic diseases, viz. epilepsy, chorea, hysteria, catalepsy, and hooping-cough; and in some painful affections, as neuralgia and gastrodynia. Though occasionally serviceable in some of these maladies, it has so frequently failed, that practitioners have ceased to place much confidence in it.

Externally, it is employed in the form of powder, or lotion, or ointment. As a *dusting powder* it is useful, by its mild, absorbent, and desiccant properties, and is applied to impetiginous and other chronic diseases of the skin, attended with profuse secretion. It is also used to allay or prevent excoriation in children and bedridden persons, and to remove chaps and cracks of the nipples. In painful ulcers, with copious discharge, it is not unfrequently beneficial by its desiccant and sedative properties. *Diffused through water* or a *mucilaginous solution* (in the proportion of two drachms of the oxide to six or eight ounces of liquid), it is occasionally useful in chronic ophthalmia, especially *ophthalmia tarsi*. Sommé[z] employed an injection, composed of half an ounce of oxide and two pints of water, in gonorrhœa and leucorrhœa, with success.

Administration.—Internally, it is administered in the form of pill or powder, in doses of from two or three grains gradually increased to eight, ten, or more.

1. **UNGUENTUM ZINCI**, L. E.; *Unguentum Zinci Oxydi*, D. (Oxide of Zinc, ℥j.; Lard, ℥vj. M. *L.*—The *Edinburgh College* substitutes Simple Liniment for Lard.—The *Dublin College* uses of Ointment of White Wax, lbj.; Oxide of Zinc, prepared in the same manner as chalk, ʒij. M.)—This compound is employed as a mild drying ointment in porrigo, impetigo, and other skin diseases attended with profuse discharges, after extensive burns, blisters, sinapisms, &c.; to painful ulcers with excessive secretion, to the eye when affected with chronic inflammation, &c.

2. **ZINCI OXYDUM IMPURUM.**—This substance is known in the shops under the name of *Tutty* (*Tutia* seu *Tuthia*), or *Furnace Cadmia* (*Cadmia Fornacum* seu *factitia*). It is found in the chimney of the fur-

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[y] *Brit. and For. Med. Rev.* July 1838, p. 221.
[z] *Archiv. Gén. de Méd.* i. 486.

nace in which zinc ores are roasted, or in which zinciferous lead ores are smelted. When prepared by levigation and elutriation it is called *Prepared Tutty* (*Oxydum Zinci impurum præparatum; Tutia Præparata*). It is applied as a dusting powder, or as a cooling ointment (*Unguentum Oxydi Zinci impuri*; composed of Simple Liniment or Lard, 5 parts; Tutty, 1 part; M.) to excoriated surfaces.

3 ZIN'CI CHLO'RIDUM.—CHLORIDE OF ZINC.

HISTORY.—This compound, which has been long known to chemists, was first introduced into medicine by Papenguth[a], and subsequently has been recommended by Professor Hancke, of Breslau[b], and by Dr. Canquoin, of Paris[c]. It is termed *Muriate*, *Hydrochlorate*, or *Butter of Zinc*.

PREPARATION.—The easiest and cheapest method of obtaining it is by dissolving zinc, or its oxide, in hydrochloric acid, evaporating to dryness, and fusing in a glass vessel with a narrow mouth, as a Florence flask. In solution it is obtained as a secondary product in the preparation of some other metals, as of palladium (see p. 817).

PROPERTIES.—It is a whitish-grey semi-transparent mass, having the softness of wax. It is soluble in water, alcohol, and ether. It is fusible; and, at a strong heat, may be sublimed and crystallized in needles. It is very deliquescent. It unites with both albumen and gelatine to form difficultly soluble compounds, and hence it occasions precipitates with liquids containing these principles in solution. A patent has been obtained by Sir William Burnett for the preservation of wood by a solution of the chloride of zinc.

Characteristics.—Dissolved in water it may be recognised to be a chloride by nitrate of silver (see p. 226). That zinc is the base of the salt may be shewn by the tests already mentioned for the salts of this metal (p. 815).

COMPOSITION.—Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*J. Davy.*
Zinc	1	32	47	50
Chlorine	1	36	53	50
Chloride of Zinc	1	68	100	100

PHYSIOLOGICAL EFFECTS.—Its *local* action on living tissues is that of a caustic or escharotic, depending partly on its affinity for albumen and gelatine; so that when placed in contact with living parts into whose composition these organic compounds enter, the chloride exercising its affinity, destroys the life of the part, and unites with the albuminous and gelatinous matters present, and forms thus an eschar. Other chemical changes of a comparatively unimportant nature are also effected: thus, various salts found in the solids or liquids of the part may be decomposed. For example, when the chloride is applied to a cancerous sore, it decomposes the carbonate and hydrosulphuret of ammonia found in the secretion of the sore. The effects produced by the application of chloride of zinc are the following:—Soon after it has been applied a sensation of warmth is felt in the part, quickly followed by violent burning pain, which continues for seven or eight hours; that is, until the parts in contact with the chloride are dead. A white eschar is now observed, which usually separates in from eight to twelve days. Unless used in the neighbourhood of loose cellular tissue, there is rarely much swelling.

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[a] *Russ. Samml. f. Naturw. u. Heilk.* H. i. S. 79, quoted by Richter, *Ausf. Arzneim.* iv. 526.
[b] Rust's *Magazin*, 1826, Bd. 22, S. 373.
[c] Dr. Alex. Ure, *Lond. Med. Gaz.* xvii. 391.

As a caustic, chloride of zinc is not inferior in power to chloride of antimony; nay, Vogt[d] says it appears to him to be more powerful and to penetrate deeper. It decomposes the organic tissues as quickly as the nitrate of silver, but excites more burning, and for a longer time, owing to its action extending to parts placed more deeply; for it is well known that the operation of the nitrate is confined to superficial parts. Both Vogt and Canquoin agree that chloride of zinc, besides corroding the parts with which it is in contact, exercises an influence over the vital actions of neighbouring parts. To this circumstance is owing, in great part, the efficacy of the chloride in various diseases in which it has been applied, and the healthy appearance of the sore after the separation of the eschar. There is no danger of any constitutional disorder arising from the absorption of the poison, as is the case with the arsenical and mercurial caustics.

Taken *internally*, in *large doses*, it acts as an irritant or caustic poison, and affects the nervous system. Thus it produces a burning sensation in the stomach, nausea, vomiting, anxiety, short breathing, small quick pulse, cold sweats, fainting, and convulsions. Taken in *very small doses*, no obvious effects are produced, except sometimes the amelioration of certain diseases. It is supposed, in these cases, to influence the nervous system.

USES.—*Internally* chloride of zinc has been given in small, but gradually-increased doses, in scrofula, epilepsy, chorea, and (in combination with hydrocyanic acid) in neuralgia of the face.

Commonly, however, it is employed *externally:* thus Papenguth used a dilute solution of it as a lotion in fistulous ulcers of a scrofulous nature. As a *caustic* it has been applied, by Professor Hanke and Dr. Canquoin, to produce an issue, to destroy nævi materni, and, as an application to parts affected with malignant diseases, such as fungus hæmatodes and cancer, or to other intractable forms of disease, such as old syphilitic or scrofulous ulcers. The benefit is supposed not to depend merely on the escharotic effect, but on the chloride inducing a new action in the surrounding parts.

ADMINISTRATION.—*Internally* it may be given in doses of one or two grains. Hufeland recommends it to be taken dissolved in ether;

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[d] *Pharmakodynamik*, i. 363. 2^{te} Aufl.

his formula for the *Æther Zinci*, as it is called, is the following:—℞. Zinci Chlor. ʒss.; Alcoholis, ℥j.; Ætheris Sulph. ℥ij. Post aliquot dies decanta. The dose of this solution is from four to eight drops, taken twice daily.

Externally it has been used as a *Lotion*, composed of two grains of the chloride and an ounce of water; or in the form of *Paste:* this may be composed of one part of chloride of zinc, and from two to four parts of wheaten flour.

4. ZIN'CI SUL'PHAS, *L. E. D.*—SULPHATE OF ZINC.

History.—This salt is said by Schwartze[e] to have been known towards the end of the 13th, or at the commencement of the 14th century; but Beckmann affirms it was not known before the middle of the 16th century[f]. It has had various names, as *Sal Vitrioli*, *White Vitriol*, and *Gilla Theophrasti*.

Natural History.—It occurs native at Rammelsberg, near Goslar, in the Hartz; at Holywell, in Flintshire; and other places.

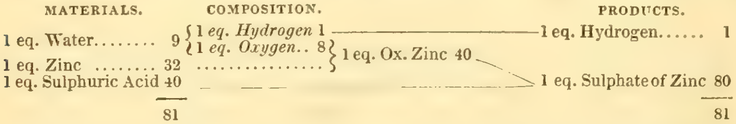
Preparation.—It is readily prepared by dissolving zinc in diluted sulphuric acid.

The *London College* orders of Zinc, in small pieces, ʒv.; Diluted Sulphuric Acid, Oij. Pour gradually the diluted Sulphuric Acid upon the pieces of Zinc, and, the effervescence being finished, strain the liquor; then boil it down until a pellicle begins to form. Lastly, set it aside that crystals may be formed.

The *Edinburgh College* observes that this salt may be prepared either by dissolving fragments of zinc in diluted sulphuric acid till a neutral liquid be obtained, filtering the solution, and concentrating sufficiently for it to crystallize on cooling,—or by repeatedly dissolving and crystallizing the impure sulphate of zinc of commerce, until the product, when dissolved in water, does not yield a black precipitate with tincture of galls, and corresponds with the characters laid down for sulphate of zinc in the List of the Materia Medica (see p. 823).

The *Dublin College* orders of Zinc, in small fragments, *thirteen parts;* Sulphuric Acid, *twenty parts;* Water, *one hundred and twenty parts.*

In this process 1 equivalent or 9 parts of water are decomposed; an equivalent or 1 part of hydrogen escapes, while an equivalent or 8 parts of oxygen unite with 1 equivalent or 32 parts of zinc, to form 1 equivalent or 40 parts of the oxide, which, with 1 equivalent or 40 parts of sulphuric acid, form 1 equivalent or 80 parts of the sulphate.



The impurities in commercial zinc have been already stated (see p. 816). If a piece of zinc be added to the impure solution of sulphate, and the liquid heated in contact with air, the iron is peroxidized and is deposited.

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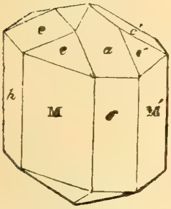
[e] *Pharm. Tabell.* 2te Ausg. 779.

[f] *Hist. of Invent.* iii. 85.

By roasting blende (*sulphuret of zinc*) in reverberatory furnaces, an impure sulphate is obtained, which is lixiviated, and the solution concentrated by evaporation, so that on cooling it forms a crystalline mass resembling lump sugar. This is distinguished among druggists by the name of *White Vitriol*, a term which they confine to this commoner kind of sulphate. This impure salt contains iron, and usually copper and lead.

PROPERTIES.—Crystals of sulphate of zinc are right rhombic prisms: they are transparent and colourless, and have a metallic astringent taste. They are soluble in $2\frac{28}{100}$ times their weight of cold water, and less than their own weight of boiling water. They are insoluble in alcohol. In dry and warm air they effloresce. When heated they undergo the watery fusion; and if the liquid be rapidly cooled, it congeals into a granular, crystalline, white mass: if the heat be continued the salt becomes anhydrous, and, at an intense heat, is decomposed, leaving a residue of zinc.

FIG. 127.



Crystal of Sulphate of Zinc.

Characteristics.—That this salt is a sulphate, is proved by the action of chloride of barium on it; a white precipitate is produced, insoluble in nitric acid (see p. 469). Acetate of lead also occasions a white precipitate. The presence of oxide of zinc in the solution is recognized by the tests already mentioned for this substance (see p. 815).

COMPOSITION.—This salt has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*	*Mitscherlich.*
Oxide of Zinc	1	40	28	32·585	55·24
Sulphuric Acid	1	40	28	30·965	
Water	7	63	44	36·450	44·76
Crystallized Sulphate of Zinc	1	143	100	100·000	100.00

PURITY.—Ammonia added to a solution of sulphate of zinc throws down a white precipitate soluble in excess of ammonia. If any oxide of iron or magnesia be present it remains undissolved; while any oxide of copper would form an azure blue solution (*cuprate of ammonia*). Arsenic or cadmium may be detected by adding excess of sulphuric acid to the solution of the sulphate, and then passing a stream of hydrosulphuric acid through it: the arsenicum and cadmium are thrown down in the form of sulphurets. The impure sulphate called *White Vitriol* occurs in irregular masses, here and there stained yellow with the iron.

Totally dissolved by water. What is thrown down by ammonia is white, and when the ammonia is added in excess it is again dissolved. On the addition of chloride of barium or acetate of lead they are decomposed. *Ph. Lond.*

When a solution in six waters is boiled with a little nitric acid, and solution of ammonia is then added till the oxide of zinc first thrown down is all redissolved, no yellow precipitate remains, or a trace only, and the solution is colourless. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—In *small and repeated doses* it acts as an astringent on the alimentary canal, checks secretion, and promotes a constipated condition of the bowels. It exercises a specific influence over the nervous system, manifested by its power of removing certain spasmodic affections: hence it is reputed antispasmodic. To the same influence is to be referred its power of preventing the recurrence of intermittent maladies, from which it has principally derived its denomination of a tonic. Its astringent effect is not confined to the bowels, but is manifested in the pulmonary and urethral mucous membranes, the secretions from which it diminishes: hence the advantage of its use in catarrhal affections of these parts. It does not appear to possess any power of checking cutaneous exhalation.

In *full medicinal doses* it is a powerful but safe emetic; it excites speedy vomiting without giving rise to that distressing nausea occasioned by emetic tartar, though this statement is not in accordance with the experience of Dr. Cullen[g], who observes that "in order to render its effects certain, the dose must generally be large; and if this is not thrown out again immediately it is apt to continue a disagreeable nausea, or even a vomiting, longer than is necessary." But this observation does not agree with the experience of other practitioners.

In *excessive doses* it acts as an irritant poison, causing vomiting, purging, coldness of the extremities, and fluttering pulse.

The *local action* of it is that of an astringent and desiccant, and in a concentrated form it is a powerful irritant and caustic. Its external use is said to have been found fatal in one case, by causing vomiting, purging, and convulsions[h]. Its causticity depends on its affinity for albumen and fibrin.

Uses.—As an *emetic* it is almost exclusively employed in poisoning, especially by narcotics. In these cases it is the best evacuant we can administer, on account of its prompt action. As an *internal astringent* it is administered in chronic dysentery[i] and diarrhœa, in chronic bronchial affections attended with profuse secretion, and in gleet and leucorrhœa. In the latter cases it is usually associated with terebinthinate medicines, and is sometimes decidedly beneficial[j]. As an *antispasmodic* it has been employed with occasional success in epilepsy, chorea, hysteria, spasmodic asthma, and hooping-cough. I have little faith in its efficacy in any of these cases. As a *tonic* it has been sometimes serviceable in agues, but it is far inferior to sulphate of quina or arsenious acid.

As a *topical astringent* sulphate of zinc is most extensively employed. We use its aqueous solution as a collyrium in chronic ophthalmia, as a wash for ulcers attended with profuse discharge, or with loose flabby granulations; as a gargle in ulcerations of the mouth, though I have found it for this purpose much inferior to a solution of sulphate of copper; as a lotion for chronic skin diseases; and as an injection in gleet and leucorrhœa.

Administration.—As an *emetic* the dose should be from ten to twenty grains; as a *tonic*, *antispasmodic*, or *expectorant*, from one to five grains.

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[g] *Treat. of the Mat. Med.*
[h] Christison, *op. cit.* p. 468.
[i] Impey, *Lond. Med. and Phys. Journ.* ix. 55, 1803.
[j] See a paper on this subject, by Mr. Graham, in the *Edinb. Med. and Surg. Journal,* vol. xxvi.

For external use, solutions are made of various strengths. Half a grain of the sulphate to an ounce of water is the weakest. The strongest I ever knew employed consisted of a drachm of sulphate dissolved in an ounce of water: it was used with success as an injection in gleet. But solutions of this strength must be applied with great caution, as they are dangerous.

ANTIDOTES.—Promote the evacuation of the poison by demulcents. Afterwards allay hyperemesis by opium, blood-letting, and the usual antiphlogistic regimen. Vegetable astringents have been advised.

5. ZIN'CI ACE'TAS.—ACETATE OF ZINC.

HISTORY.—This salt was discovered by Glauber.

PREPARATION.—It may be procured by dissolving oxide of zinc in acetic acid, and crystallizing the saturated solution; or it may be readily obtained by double decomposition: 143 grains of crystallized sulphate of zinc, dissolved in water, and mixed with 190 grains of crystallized acetate of lead in solution, will produce 152 grains of sulphate of lead, which, being insoluble, precipitates, while 91 grains of the anhydrous acetate of zinc (equal to 154 grains of the crystallized acetate) are left in solution; or it may be procured by immersing a piece of zinc in a solution of acetate of lead, until the liquid forms a white precipitate with hydrosulphuric acid. In this process the lead is reduced to the metallic state (forming the *Arbor Saturni*, or *Lead Tree*), while the zinc replaces it in solution.

PROPERTIES.—It usually crystallizes in rhomboidal plates, having a pearly or silky lustre, closely resembling talc. The form of the crystals is the oblique rhombic prism. The salt is odourless, but has a bitter metallic taste. It dissolves readily in water, and is slightly efflorescent.

Characteristics.—When heated it fuses, and gives out an inflammable vapour, having the odour of acetic acid. When sulphuric acid is added to the salt, the vapour of acetic acid is evolved: this is easily recognized by its odour. These characters show it to be an acetate. That it is a zincic salt is proved by the tests before mentioned for a solution of this salt (p. 815).

COMPOSITION.—Its composition is, according to Dr. Thomson, as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Oxide of Zinc	1	40	26·00
Acetic Acid	1	51	33·11
Water	7	63	40·90
Crystallized Acetate of Zinc	1	154	100·00

PHYSIOLOGICAL EFFECTS.—Its effects are analogous to those of the sulphate of zinc. Its local action is astringent. Taken internally, in small doses, it acts as a tonic and antispasmodic; large doses occasion vomiting and purging. Devaux and Dejaer[k] deny that it is a poison, even in large doses.

Uses.—It is rarely administered *internally;* but is applicable as an emetic, tonic, and antispasmodic, in the same cases in which the oxide or sulphate of zinc is employed.

As a *topical* remedy, it is used on account of its astringent qualities in chronic ophthalmia, gleet, and leucorrhœa. In the latter stages of gonorrhœa I have found it far more successful than the sulphate. Its beneficial effects were first described by the late Dr. Wm. Henry, of Manchester[l]. Sir A. Cooper[m] recommends, as the best injection which can be used in the third week of gonorrhœa, a mixture of six grains of sulphate of zinc and four ounces of liquor plumbi subacetatis dilutus. Of course double decomposition takes place, and the active ingredient is the acetate of zinc.

Administration.—When exhibited internally, as a tonic or antispasmodic, the dose is one or two grains gradually increased. As an emetic it is rarely administered: the dose is from ten grains to a scruple: its operation is very safe. As a lotion or injection, it is employed in the form of aqueous solution, containing two or more grains of the salt to an ounce of water.

ZINCI ACETATIS TINCTURA, D. (Sulphate of Zinc; Acetate of Potash, āā *one part.* Triturate them together, and add sixteen parts of Rectified Spirit; macerate for a week with occasional agitation, and filter through paper.)—Here we have double decomposition: sulphate of potash and acetate of zinc are formed. The first is precipitated, being insoluble in spirit, the second remains in solution. One drachm contains a quantity of acetate of zinc equal to about four grains of the crystallized acetate. When diluted with water it is used as a collyrium and injection.

6. ZIN′CI CAR′BONAS.—CARBONATE OF ZINC.

(Calamina; Carbonas Zinci impura, *L.*—Calamina præparata; Levigated impure Carbonate of Zinc, *E.*—Carbonas Zinci impurum; Calamina, *D.*)

History.—The native carbonate of zinc was perhaps known to the ancients, though they were unacquainted with its nature. The term *Calamine* is applied both to the native carbonate and native silicate of zinc: the latter is termed by way of distinction *Electric Calamine.*

Natural History.—Native carbonate of zinc (*Calamine*) is found in great abundance in several parts of England (in the counties of Somerset, Derby, Durham, &c.), as well as in various parts of the continent of Europe (in Carinthia, Hungary, Silesia, &c.) It occurs crystallized or in compact or earthy masses. Its colour varies, being more or less grey, yellow, or brown. Its sp. gr. is 4·2 to 4·5.

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[k] Orfila, *Toxicol. Gén.*
[l] *Lond. Med. and Phys. Journ.* ix. 53. 1803.
[m] *Lancet,* iii. 199.

Preparation.—Calamine (*Calamina*), or the impure carbonate of zinc (*Carbonas Zinci impura*), is directed to be calcined, in order to make it pulverizable. But in this process water and more or less of the carbonic acid is expelled. It is then reduced to a very fine powder (usually in mills), and is afterwards submitted to the process of elutriation. By this means we obtain *Prepared Calamine* (*Calamina Præparata*, L. E.; *Zinci Carbonas impurum præparatum*, D.)

Properties.—Prepared calamine is met with in the shops in the form of a heavy pinkish or flesh-coloured powder, or made up into little masses. When pure, it dissolves in nitric, hydrochloric, or sulphuric acid, with effervescence. Various impurities mixed with calamine are insoluble in these acids.

Characteristics.—The effervescence with the mineral acids shows calamine to be a carbonate. The presence of zinc in the solution is determined by the tests before mentioned for this metal (p. 815). The action of these tests, however, is more or less impeded by the presence of foreign matters in calamine.

Composition.—Carbonate of zinc has the following composition:—

				Smithson.		
	Atoms.	*Eq. Wt.*	*Per Cent.*	(Mendip Ore.)		(Derbyshire Ore.)
Oxide of Zinc	1	40	64·5	64·8	to	65·2
Carbonic Acid	1	22	35·5	35·2	to	34·8
Carbonate of Zinc	1	62	100·0	100·0	to	100·0

Impurities.—The substance sold in the shops as prepared calamine frequently contains only traces of zinc. If hydrochloric acid be poured on it, effervescence (owing to the escape of carbonic and hydrosulphuric acids) takes place, and a portion is dissolved; but the greater part remains undissolved. Mr. Brett[n] found from 78 to 87·5 per cent. of sulphate of baryta. The remainder of the powder consisted of oxide of iron, carbonate of lime, lead [sulphuret of?] and mere traces of zinc.

Physiological Effects.—Pure carbonate of zinc is probably similar in its action to the oxide.

Uses.—Calamine is employed as a dusting powder for children, and as a mild desiccant and astringent in excoriations, superficial ulceration, &c.

1. CALAMINA PRÆPARATA, L.; *Zinci Carbonas impurum præparatum*, D. *Lapis Calaminaris præparatus.* (Burn the Calamine, then bruise it. Afterwards let it be made into a very fine powder in the same manner as we have directed chalk to be prepared, *L.*—The directions of the *Dublin College* are essentially similar). Some remarks on the preparation have been previously offered. The *Edinburgh College* gives no direction for the preparation of calamine.

2. CERATUM CALAMINÆ, L. E.; *Unguentum Calaminæ*, D.; *Turner's Cerate*; *Ceratum Epuloticum.* (Calamine; Wax, āā lbss.; Olive

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[n] *Lond. Med. Gaz.* xx. 72.

Oil, f℥xvj. Add the calamine to the melted wax and oil when they begin to thicken, *L.*—The *Edinburgh College* uses of prepared Calamine, *one part*; and Simple Cerate, *five parts.*—The *Dublin College* employs of prepared Calamine, lbj.; and Ointment of Yellow Wax, lbv. M.) It is an excellent desiccant and astringent application (when prepared with good calamine) to burns, scalds, excoriations, superficial ulcerations, &c.

NON-OFFICINAL PREPARATION OF ZINC.

ZINCI CYANIDUM; *Hydrocyanate*, *Cyanide*, or *Cyanuret of Zinc.* This salt was introduced, by the German physicians, as a substitute for hydrocyanic acid. It is prepared by adding recently-made oxide of zinc to hydrocyanic acid; or by adding a solution of sulphate of zinc to a solution of cyanide of potassium. It is a white powder, insoluble in water or alcohol. If a strong mineral acid be added to it, hydrocyanic acid is developed, and a soluble salt of zinc obtained. The latter is recognised by the tests before mentioned for a solution of zinc (p. 815). It consists of one equivalent or 32 parts of *Zinc*, and one equivalent or 26 parts of *Cyanogen.*

Its effects have not been carefully ascertained, but they are supposed to be similar to those of hydrocyanic acid. It has been used principally in affections of the nervous system, as epilepsy, hysteria, and chorea. It has also been employed in cardialgia and cramps of the stomach, and as an anthelmintic in children. The dose is a quarter of a grain to a grain and a half three times a day. It may be taken in the form of powder mixed with calcined magnesia.

ORDER XXVII.—IRON AND ITS COMPOUNDS.

1. FER'RUM, *L. E. D.*—IRON.

(Ramenta, *L.*–Filum; Limatura, *E.*—Fila; Scobs, Oxydi Squamæ, *D.*)

History.—This metal (called by the alchymists *Mars*) was known in the most ancient times. It was employed medicinally at a very early period, namely, above 3200 years ago. Indeed, it appears to have been the first mineral used internally; and a curious anecdote is given of its introduction into medicine. Melampus (a shepherd supposed to possess supernatural powers) being applied to by Iphicles, son of Philacus, for a remedy against impotence, slaughtered two bulls, the intestines of which he cut to pieces, in order to attract birds to an augury. Among the animals which came to the feast was a vulture, from whom Melampus pretended to learn that his patient, when a boy, had stuck a knife, wet with the blood of some rams, into a consecrated chestnut-tree, and that the bark had subsequently enveloped it. The vulture also indicated the remedy, namely, to procure the knife, scrape off the rust, and drink it in wine, for the space of ten days, by which time Iphicles would be lusty, and capable of begetting children. The advice thus given by Melampus is said to have been followed by the young prince with the most perfect success![o]

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[o] Le Clerc, *Hist. de la Médecine.*

NATURAL HISTORY.—Iron is met with in both kingdoms of nature.

α. IN THE INORGANISED KINGDOM.—Few minerals are free from iron. It is found in the metallic state (*native iron*), in combination with oxygen (*hæmatite, micaceous iron, brown iron stone*, and *magnetic iron ore*), with sulphur (*iron pyrites*, and *magnetic pyrites*), with chlorine (*pyrosmalite*), and with oxygen and an acid (*carbonate, phosphate, sulphate, arseniate, tungstate, tantalate, titaniate, chromate, oxalate*, and *silicate*).

β. IN THE ORGANISED KINGDOM.—It occurs in the ashes of most plants, and in the blood and some other parts of animals.

EXTRACTION.—In Sweden, iron is extracted from magnetic iron ore and micaceous iron: in England, principally from clay iron ore (*carbonate of iron*).

Clay iron ore (technically called *Mine*) is burned with coal in large heaps, by which it loses carbonic acid, water, and sulphur. It is then smelted with a flux (in South Wales this is limestone; in the forest of Dean, clay;) and coke. The smelted iron is run into moulds, and is then called *Cast Iron* (*Ferrum fusum*) or *Pig Iron*. This contains carbon, oxygen, silicon, and often sulphur and phosphorus. To separate these, it is submitted to several processes (called refining, puddling, and welding), by which it is converted into *Wrought Iron* (*Ferrum cusum*)[p].

PROPERTIES.—The primary form of the crystals of native iron is the regular octohedron. Pure iron has a whitish grey colour, or, according to Berzelius, is almost silver white. When polished it has much brilliancy: its taste is peculiar and styptic; when rubbed it becomes odorous. Its ductility and tenacity are great; its malleability comparatively small. Its sp. gr. is 7·788, but diminishes by rolling or drawing. It is attracted by the magnet, and several of its compounds are capable of becoming permanent magnets; but pure iron retains its magnetic property for a short time only. It requires a very intense heat to fuse it; and it is not volatile at any known temperature; while in the softened state, previous to melting, it is capable of being welded. Its equivalent or atomic weight is 28.

Characteristics.—Iron readily dissolves in diluted sulphuric acid, with the evolution of hydrogen gas. The solution contains the protosulphate of iron, and produces, on the addition of caustic potash or soda, a greenish-white precipitate (the *hydrated protoxide*): this precipitate, by exposure to the air, attracts oxygen, and is converted into the red or sesquioxide. Auro-chloride of sodium forms a purple precipitate with the protosalts of iron. By boiling the solution of the protosulphate with a little nitric acid, we obtain a persulphate of iron, recognized by ferrocyanide of potassium, causing a blue precipitate; sulphocyanic or meconic acid, a red colour; gallic or tannic acid, or infusion of galls, a purple or bluish black; and succinate, or benzoate of ammonia, a yellowish precipitate.

PHYSIOLOGICAL EFFECTS. α. **Of the Metallic Iron.**—Iron is probably inert so long as it retains its metallic form, but it readily oxidizes in the alimentary canal, and thereby acquires medicinal power. As acids promote this chemical change, acid wines and fruits assist in rendering the metal active, while alkalis and their carbonates have an opposite effect. The oxidizement of the iron is attended with the evolution of hydrogen gas, which gives rise to unpleasant eructations. If sulphur be taken along with iron, hydrosulphuric acid is developed. Like the ferruginous preparations generally, the internal employment of iron causes blackening of the stools. The nature of the effects produced by oxide of iron formed in the alimentary canal will be best examined hereafter, under the head of ferruginous preparations. I may, however, remark here, that it is one of the few metals which by oxidizement is not rendered more or less poisonous.

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[p] *Manufacture of Iron*, in the *Library of Useful Knowledge;* also, *Treatise on Iron and Steel*, in *Lardner's Cyclopædia*.

β. **Of the Ferruginous Compounds.** *α α. On Vegetables.*—Most of the compounds of iron do not appear to be hurtful to plants: at least this is the case with the oxides[q]. The sulphate, however, is injurious.

β β. On Animals.—The effects of the ferruginous compounds on animals generally are similar to those on man. It is stated that in animals to whom iron has been given for a considerable time, the spleen has been found smaller, harder, and denser—an effect which is supposed to be owing to the increased contractile power experienced by the veins of the abdomen. The liver is also said to have been affected in a similar manner, though in a somewhat slighter degree.

γ γ. On Man.—The *local* effects of the sulphate and chloride of iron are those of irritants, and these preparations accordingly rank among poisons: but they are not equal in power to the mercurial or cupreous salts. Most of the ferruginous preparations are astringent; that is, they constringe the parts with which they are in contact, and thereby diminish secretions and check sanguineous discharges. Thus, when swallowed, they repress the secretions and exhalation of the gastro-intestinal membrane, and thereby render the alvine evacuations more solid, and even occasion costiveness. The sulphate and chloride of iron are the most powerful of the ferruginous astringents. Administered in large quantities, or when the alimentary canal is in an irritable condition, all the compounds of iron are capable of exciting heat, weight, and uneasiness at the præcordia, nausea, and even vomiting, and sometimes purging.

The constitutional or *remote* effects[r] of the chalybeates are principally observed in the alteration induced in the actions of the vascular and muscular systems, and are best seen in that state of the system denominated *anæmia*, or more properly *hypæmia*[s], in which both the quantity and quality of the blood appear defective.

We have a good illustration of this state in chlorotic patients. The skin appears pale and almost exsanguineous, the cellular tissue is œdematous, and, after death, the larger vessels as well as the capillaries are found to be imperfectly supplied with blood. Patients with this condition of system are affected with great feebleness, loss of appetite, and palpitation; and in females the catamenial secretion is frequently, but not invariably, defective. That the want of uterine action is not the cause, but in some cases is, perhaps, the effect of this condition of system, seems tolerably clear from the circumstance of the same constitutional symptoms of anæmia sometimes occurring with a perfect regularity of the uterine functions; moreover, we occasionally meet with anæmia in men. It is sometimes the consequence of hemorrhages—at other times it occurs spontaneously, and without any known cause[t].

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[q] De Candolle, *Phys. Vég.* 1837.

[r] The best account of the physiological effects of iron is that published by Menghini (*De Ferrearum particularum progressu ad sanguinem*) in the *Comment. Acad. Bonon.* t. ii. pt. iii. p. 475. A notice of these is given by Bayle in his *Bibliothèque de Thérapeutique*, t. iv. Paris, 1837.

[s] See p. 5.

If in this condition of system we administer iron, the appetite increases, digestion is promoted, the pulse becomes fuller and stronger, the skin assumes its natural tint, the lips and cheeks become more florid, the temperature of the body is increased, the œdema disappears, and the muscular strength is greatly augmented. The alvine evacuations assume a black colour, as they always do under the use of the ferruginous preparations. After continuing the use of iron for a few weeks, we frequently find excitement of the vascular system (particularly of the brain); thus we have throbbing of the cerebral vessels, and sometimes pain in the head, a febrile condition of system, with a tendency to hemorrhage. Mr. Carmichael[u] considers the *sanguine* temperament (marked by a high complexion, celerity of thought, remarkable irritability of fibre, and a quick pulse) as depending on an excess of iron in the system; whereas the *leucophlegmatic*, or *relaxed*, temperament (characterized by a pale bloated countenance, dull eyes, mind heavy and slow in receiving and forming ideas, little irritability of fibre, and pulse small and feeble) as depending on a deficiency of iron.

When by the use of iron the state of the general system improves, the secretions resume their natural condition; and thus at one time we observe this metal promoting the uterine discharge, at another checking it, according as chlorosis or menorrhagia had been previously present; we cannot, therefore, regard the preparations of this metal as having any direct emmenagogue effect, as some have supposed.

Some refer all the other symptoms of anæmia to the abnormal state of the blood, and ascribe the beneficial influence of iron to the improvement in the quality of this liquid. It is certain that, under the use of the preparations of this metal, the blood frequently acquires a more scarlet colour, owing probably to an increase in the number of its colouring particles; and the crassamentum becomes firmer and more solid, and even increased in quantity. This alteration of the physical and chemical properties of the blood must render it more stimulating, and thus the different organs, receiving a fluid of a more healthy character, resume their normal condition, and perform their functions in a proper manner. Tiedemann and Gmelin[v] have detected it in the serum of the blood of the portal and mesenteric veins of horses and dogs, to whom they administered either the sulphate or chloride. Occasionally, too, iron has been found in the urine. Moreover, Menghini[w] asserts, that the quantity of iron in the blood of dogs may be increased by feeding them on substances mixed with this metal. Furthermore, it is not to be forgotten, that iron exists in no inconsiderable quantity in healthy blood, and is supposed to contribute to its colour, and probably to its stimulant properties; so that it is not unlikely any variation in the quantity of this metal would be attended with an alteration in the action of every organ.

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[t] Andral, *Pathol. Anal.* by Townsend and West, i. 97.

[u] *Essay on the Effects of Carbonate of Iron on Cancer*, Dubl. 1806, p. 396.

[v] *Vers. üb. d. Wege auf welch. Subst. aus d. Magen u. Darmk.*

Iron is a substance not readily absorbed, for it remains in the stomach and intestines many days after it is swallowed: in order, therefore, that the ferruginous preparations should have much effect on the general system, it is necessary that they be employed for some considerable time. It does not, like most other metals, act as a poison when it gets into the blood.

Another circumstance connected with the operation of iron is likewise deserving of notice; namely, that it has no primary or specific effect on the nervous system, as arsenic, mercury, copper, zinc, bismuth, silver, and many other metals. It must not, however, be imagined from these remarks, that the preparations of iron never operate injuriously. On the contrary, we see them sometimes acting as local irritants on the alimentary canal, as already noticed; and by the use of them in too large quantities, or for too long a period of time, they bring on a hypersthenic or phlogistic diathesis.

USES. α. **Of Metallic Iron.**—Iron filings have been used in those cases where the chalybeate preparations generally have been administered, and which will be hereafter noticed. In some instances, however, the efficacy of iron depends on its being employed in the uncombined state. Thus, when used as an antidote to poisoning by the salts of copper, it is necessary that the iron be administered in the metallic state, in order to reduce the cupreous salts. Iron filings have been regarded as anthelmintic, especially in the small threadworm (the *Ascaris vermicularis*); they have been used also as an astringent application, to repress fetid secretion of the feet.

β. **Of the Ferruginous Compounds.** — By a careful attention to the known physiological effects of the ferruginous compounds, the indications and contra-indications for their employment may be in great part learned. Thus, the impropriety of administering them where there is irritation or inflammation of the alimentary canal, in plethoric habits, and in persons disposed to inflammatory diseases, or to apoplexy, will be obvious from the foregoing remarks. On the other hand, in all cases characterized by feebleness and inertia of the different organs of the body, by a soft lax condition of the solids, and by a leucophlegmatic state of the system—where the patient appears to be suffering from a state of general anæmia, already described—the preparations of iron are indicated. It is hardly within the scope of my present object to instance particular diseases where this metal may be used, but rather to point out those conditions of system which affect the employment of iron in diseases generally. I may notice a few cases by way of illustration.

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[w] *De Ferrearum particul. progressu ad sanguinem.* In *Com. Acad. Bonon.* t. ii. pt. iii. p. 475.

As *external* or *local* agents we rarely employ the preparations of iron, since we have other more efficacious and powerful remedies. Occasionally, however, they have been used as astringents, styptics, and caustics. Thus solutions of the sulphate and chloride have been used in the form of injection, in discharges from the urethra and vagina: and the tincture of the chloride is now and then applied as a styptic, or to repress the growth of spongy granulations.

The ferruginous preparations are usually resorted to with the view of affecting the general system. They are frequently given to *promote the uterine functions*, as in chlorosis, amenorrhœa, dysmenorrhœa, and menorrhagia, and often with success. When chlorosis depends on, or at least is accompanied by, that condition of the system before described under the name of anæmia, the ferruginous preparations are frequently useful; but if it occur in patients of a full habit, or if it arise from inflammation of some organ (as the lungs, stomach, or bowels), chalybeates will do harm. In cases of impotence, connected with or arising from general feebleness, it may be now and then useful: but in nine out of ten cases which we are called on to treat, this condition arises from indulgence in bad habits, which no medicine can affect. Sometimes iron is resorted to in sterility (though Dioscorides says the rust of iron hinders women from conceiving), but the conditions under which it is likely to be useful are precisely those before mentioned for other diseases. In discharges from the genital organs, as gleet and leucorrhœa, the internal employment of the tincture of the chloride of iron, sometimes conjoined with the tincture of cantharides, has been found useful.

In some *periodical diseases*—namely, ague, asthma, and tic douloureux—the ferruginous preparations have gained considerable repute. In the first of these diseases (that is, ague), the sulphate has been used by Marc[x] and others, the subcarbonate by Buchwald, the ammoniacal chloride by Hartmann; but it has been almost wholly superseded, of late years, by the sulphate of quinine and by arsenic. In asthma, Dr. Bree[y], who was himself a sufferer from the disease, regards iron as preferable to all other remedies. However, the experience of others has not confirmed his favourable opinion of it. The sesquioxide of iron has latterly been extensively employed, at the recommendation of Mr. B. Hutchinson[z], in tic douloureux, and with variable success; in some cases acting in a most extraordinarily beneficial manner, in others being of no avail.

In *diseases of the spleen and liver*, the ferruginous compounds are occasionally found useful. I have already alluded to the influence which they are supposed to possess over these organs; a supposition the more probable from the occasional remarkable effects produced by them in diseases of these organs. "I regard iron as a *specific*," says Cruveilhier[a], "in *hypertrophy of the spleen*, or *chronic splenitis;* whether primitive or consecutive to intermittent fevers." After noticing the symptoms attending this condition (such as paleness of the lips, &c. great lassitude, abdominal and cephalic pulsations, brought on by the slightest exertion, pain at the left side, disordered state of the digestive organs, accelerated pulse, and heart easily excited), he goes on to remark, "By the aid of iron I have obtained the complete resolution of enlargements of the spleen, which have occupied half, or even two-thirds, of the abdomen." In hypertrophy of the liver, iron has not been equally serviceable.

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[x] *Recherches sur l'Emploi du Sulf. de Fer dans le Traitement des Fièvres Interm.* Paris, 1810.

[y] *A Practical Inquiry on Disordered Respiration, distinguishing Convulsive Asthma, its Specific Causes*, &c. Birmingham, 1797.

[z] *Cases of Tic Douloureux successfully treated.* 1820.

Some years ago the preparations of iron were strongly recommended in *cancer* by Mr. Carmichael[b]. The grounds on which he was led to the use of them were the probability that cancer had an independent life—in other words, that it was a kind of parasite, as some preceding writers, more particularly Dr. Adams, had presumed; and secondly, the efficacy of iron in destroying intestinal worms, which led him to hope that it would be equally destructive to other parasites. With these views he employed (externally and internally) various ferruginous compounds—namely, the ferrotartrate of potash, the subcarbonate (sesquioxide) of iron, and the phosphates. Whatever hopes may have at one time been entertained of these remedies as curative agents, in this most intractable disease, they are now completely destroyed. That these medicines are occasionally useful as palliatives may perhaps be admitted; but they have no curative powers. Indeed this might have been suspected, from the hypothetical grounds on which they were introduced into use. The proofs of the parasitical nature of cancer must be much stronger than any yet offered, ere we can admit this hypothesis. Moreover, the preparations of iron, though useful, are not so "very effectual" in worms as Mr. Carmichael's remarks would lead us to imagine.

In certain affections of the digestive organs, the preparations of iron are occasionally used with benefit; as in some forms of dyspepsia, but only in the conditions of system already noticed.

In some *affections of the nervous system* which occur in weak debilitated subjects, it is also useful; for example, in epilepsy, chorea, hysteria, and the shaking palsy produced by the vapour of mercury.

These are the most important diseases for which we employ the ferruginous compounds. There are many other diseases for which chalybeates are occasionally beneficial; but the general principles regulating their use will be readily comprehended from the foregoing remarks, and I have only to add, that in all diseases attended by debility and marked by atony and inertia of organs, more especially in those indicating a disordered state of the hæmatose functions, the preparations of iron will be found in most instances more or less serviceable. Furthermore, I may enumerate scrofula, rickets, dropsy, and gout, as diseases in which iron has been at times used with advantage.

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[a] *Dict. de Méd. et de Chir. Prat.* t. viii. p. 62.
[b] *Op. supra cit.*

ADMINISTRATION.—Iron in substance is admininstered in the form of filings. These are procured from the workshop of the smith, and are usually impure, being mixed with the filings of other metals, &c. The magnet is generally employed to separate the ferruginous from other particles, but it does this imperfectly, as various impurities cling to the iron particles. The only way to procure them pure is by filing a piece of pure iron with a clean file. The dose of iron filings is from ten to thirty grains, given in the form of an electuary made with treacle, honey, or some other thick substance.

2. FER′RI OX′YDUM NI′GRUM, *D.*—BLACK OXIDE OF IRON.

(Ferri Oxidum Nigrum, *E.*)

HISTORY.—It was first employed as a medicine by Lemery in 1735. It is the *Martial Ethiops* (*Æthiops Martialis*) of some writers, and the *Oxydum ferroso-ferricum* of Berzelius. It is sometimes termed the *Magnetic Oxide.*

NATURAL HISTORY.—It occurs in the mineral kingdom under the name of *Magnetic Iron Ore*, the massive form of which is called *Native Loadstone.* It is found in Cornwall, Devonshire, Sweden, &c.

PREPARATION.—Directions for its preparation are given by both the Edinburgh and Dublin Colleges.

The *Edinburgh College* orders of Sulphate of Iron, ℥vj.; Sulphuric Acid (commercial) fʒij. and f℈ij.; Pure Nitric Acid, fʒiv.; Stronger Aqua Ammoniæ, f℥ivss.; Boiling Water, Oiij. Dissolve half the sulphate in half the boiling water, and add the sulphuric acid; boil; add the nitric acid by degrees, boiling the liquid after each addition briskly for a few minutes. Dissolve the rest of the sulphate in the rest of the boiling water; mix thoroughly the two solutions; and immediately add the ammonia in a full stream, stirring the mixture at the same time briskly. Collect the black powder on a calico-filter; wash it with water till the water is scarcely precipitated by solution of nitrate of baryta; and dry it at a temperature not exceeding 180°.

The object of the first part of this process is to convert the sulphate of the protoxide of iron into the sulphate of the sesquioxide. This is effected by adding nitric acid to the boiling solution. The acid gives oxygen to the protoxide, while binoxide of nitrogen gas escapes. The additional quantity of sulphuric acid is required to enable the salt to preserve its neutrality, and prevent the deposition of a basic sulphate of the sesquioxide. If, however, the sulphate of iron directed to be used be a pure protosulphate, the additional quantity of sulphuric acid ordered by the Edinburgh College is not sufficient for the purpose. On the addition of ammonia to the mixed solution of the protosulphate and sesquisulphate of iron, a compound of the hydrated protoxide and sesquioxide of iron is precipitated. This is to be washed with water until all traces of sulphuric acid are got rid of. When dried at 180° it constitutes the *Ferri Oxidum nigrum* of the Edinburgh Pharmacopœia.

The *Dublin College* orders it to be prepared as follows:—Let the scales of Oxide of Iron [*Ferri Oxydi Squamæ*], which are to be found at the smiths' anvils, be washed with water; and when dried, let them be detached from impurities by application of a magnet. Then let them be reduced to powder, of which let the most subtile parts be detached, according to the mode directed for the preparation of chalk.

Scales of iron are composed of a mixture or combination of protoxide and sesquioxide; but they are not uniform in constitution. The process of the Dublin Pharmacopœia has the advantage of cheapness.

There are several other methods of procuring this compound. In the Paris Codex it is directed to be prepared by covering iron with water and exposing the mixture to the air: then, by elutriation, separating the black powder.

PROPERTIES.—The crystalline form of the magnetic iron ore is the regular octohedron. The black oxide of iron of the Pharmacopœia is a greyish-black powder, with a velvety appearance, and is strongly magnetic. It dissolves in hydrochloric acid without effervescence. Prepared according to the Edinburgh Pharmacopœia its properties are as follows:—

"Dark grayish-black: strongly attracted by the magnet: heat expels water from it: muriatic acid dissolves it entirely; and ammonia precipitates a black powder from this solution." *Ph. Ed.*

COMPOSITION.—The following is the composition of this oxide:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay Lussac.*
Iron	3	84	72.414	72·5
Oxygen	4	32	27·586	27·5
Black Oxide of Iron	1	116	100·000	100·0

Or	*Atoms.*	*Eq. Wt.*
Protoxide	1	36
Sesquioxide	2	80
	1	116

It has been above stated that the constitution of scales of oxide of iron is variable. The following is their composition according to Mosander:—

	Outer Layer.		*Inner Layer.*	
	Atoms.	*Eq. Wt.*	*Atoms.*	*Eq. Wt.*
Protoxide of Iron	2	72	3	108
Sesquioxide of Iron	1	40	1	40
Scales of Iron	1	112	1	148

PURITY.—Black oxide of iron should be readily soluble in hydrochloric acid without effervescence; by which the absence of metallic iron is shown.

PHYSIOLOGICAL EFFECTS AND USES.—These are similar to those of the chalybeates in general, and which have been already described. It does not produce local irritation. It is a more valuable preparation than the sesquioxide, in consequence of being more readily soluble in the fluids of the stomach.

ADMINISTRATION.—Dose from grs. v. to ℈j. or more, twice or thrice daily.

3. FER'RI SESQUIOX'YDUM, *L.*—SESQUIOXIDE OF IRON.

(Ferri Oxidum rubrum, *E.*—Ferri Oxydum rubrum; Ferri Rubigo; and Ferri Carbonas, *D.*)

History.—Geber[c] was acquainted with this substance, which he calls *Crocus Martis.* It was probably known long before his time. It is the *Red* or *Peroxide of Iron* of some chemists.

Natural History.—It is found native in the crystallized state (*Specular Iron* or *Iron Glance*) and in globular and stalactitic masses (*Red Hæmatite*): the finest specimens of the first occur in the Isle of Elba; the second is found near Ulverstone, in Lancashire, and in Saxony. The hydrated sesquioxide of iron (*Brown Iron Stone*) is met with in Scotland, and at Shotover Hill, Oxfordshire.

Preparation.—There are several modes of preparing this compound:—

1. **By precipitation from Sulphate of Iron.**

The *London College* orders of Sulphate of Iron, lbiv.; Carbonate of Soda, lbiv. and ℥ij.; Water, boiling, *Cong.* vj. Dissolve the Sulphate of Iron and Carbonate of Soda, separately, in three gallons of Water; then mix the liquors together, and set them by, that the powder may subside. Lastly, the supernatant liquor being poured off, wash what is precipitated with water, and dry it.

The *Edinburgh College* employs, of Sulphate of Iron, ℥iv.; Carbonate of Soda, ℥v.; Boiling Water, Oss.; Cold Water, Oiijss. Dissolve the sulphate in the boiling water, add the cold water, and then the carbonate of soda, previously dissolved in about thrice its weight of water. Collect the precipitate on a calico filter; wash it with water till the water is but little affected with solution of nitrate of baryta, and dry it in the hot-air press, or over the vapour bath.

The *Dublin College* orders it [*Ferri Carbonas,* D.] to be prepared with *twenty-five parts* of sulphate of iron, *twenty-six parts* of carbonate of soda, and *eight hundred parts* of water.

In this process one equivalent or 76 parts of sulphate of iron are decomposed by one equivalent or 54 parts of carbonate of soda: and the products of their mutual reaction are one equivalent or 58 parts of carbonate of the protoxide of iron which are precipitated, and one equivalent or 72 parts of sulphate of soda which remain in solution.

MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Carbon. Soda..	54	1 *eq. Soda*	32	1 eq. Sulphate of Soda....	72
		1 *eq. Carbonic Acid*	22		
1 eq. Sulphate Iron	76	1 *eq. Sulphuric Acid*	40		
		1 *eq. Oxide of Iron*	36	1 eq. Carbonate of Iron ..	58
	130		130		130

By exposure to the air during the washing and drying, the carbonate of the protoxide of iron is decomposed, the oxygen of the air combines with the protoxide, and thereby converts it into sesquioxide, while carbonic acid is disengaged.

When prepared according to the above directions its colour is reddish chocolate brown, and it usually contains a small portion of undecomposed carbonate of the protoxide of iron. Manufacturers, however, usually calcine it in an iron pot, by which it acquires a brownish red colour and is more saleable.

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[c] *Invention of Verity,* p. 280.

Sesquioxide of iron, as thus procured, is frequently termed *Carbonate* or *Subcarbonate of Iron* (*Ferri Carbonas*, D.), or *Precipitated Carbonate of Iron* (*Ferri Carbonas Præcipitatus*).

2. By calcining Sulphate of Iron.

The *Dublin College* orders it [*Ferri Oxydum Rubrum*, D.] to be prepared as follows:—Let sulphate of iron be exposed to heat until the water of crystallization shall be expelled; then, with a strong fire, let it be roasted so long as acid vapour rises. Let the red oxide be washed until the washings, when examined by litmus, shall appear free from acid. Lastly, let it be dried on bibulous paper.

In this process the water and sulphuric acid of the crystallized sulphate of iron are evolved. The iron is peroxidized at the expense of a portion of the sulphuric acid, while some sulphurous acid is developed.

Sesquioxide of iron, prepared by this process, is known in commerce as *Colcothar*, *Caput Mortuum Vitrioli*, *Trip*, *Brown-red*, *Rouge*, *Crocus* [d].

3. From Rust of Iron.

The *Dublin College* orders Rust of Iron (*Rubigo Ferri*, D.) to be thus prepared: Take of iron wire any required quantity. Moisten it with water, and expose it to the air until it is corroded into rust. Then let it be rubbed in an iron mortar; and, by the affusion of water, let the most subtile powder be washed off and dried.

It is directed to be prepared from iron wire on account of its purity. Rust of iron is usually reduced to an impalpable powder by levigation and elutriation; and is then made up into small conical loaves like prepared chalk.

Properties.—The primary form of the crystals of native sesquioxide of iron is the rhombohedron.

The artificial sesquioxide of the shops is a brownish red powder: when it has been exposed to an intense heat it has a purplish tint. It is odourless, insoluble in water, and not magnetic. Prepared according to the London Pharmacopœia it has a styptic taste; when calcined it is tasteless. When quite free from carbonate of iron, it dissolves in hydrochloric acid without effervescence.

Characteristics.—Its hydrochloric solution affords a deep blue precipitate with the ferrocyanide of potassium; a purplish black precipitate with tincture of nutgalls; a brownish-red precipitate with the alkalis; and a red colour with sulphocyanic or meconic acid.

Composition.—Sesquioxide of iron has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Gay-Lussac.*	*Berzelius.*
Iron	1	28	70	70·27	69·22
Oxygen	$1\frac{1}{2}$	12	30	29·73	30·78
Sesquioxide of Iron	1	40	100	100·00	100·00

Purity.—Adulteration is hardly to be apprehended. If it should contain copper, its hydrochloric solution will deposit this metal on a bright rod of iron. After the sesquioxide has been thrown down by ammonia from the hydrochloric solution, the supernatant liquor should give no indications of containing any other metal in solution; and chloride of barium ought not to occasion any precipitate. Orfila[e] obtained traces of arsenic in the sesquioxide of commerce, by boiling this substance for five hours with pure sulphuric acid, and placing the solution in Marsh's apparatus.

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[d] "The scarlet parts are called *rouge;* the red, purple, or bluish parts, being those which have been exposed to the strongest heat, are called *crocus.*" (Gray's *Operative Chemist*, p. 696. Lond. 1828.)

Dissolved totally by dilute hydrochloric acid with very slight effervescence, and it is precipitated by ammonia. *Ph. Lond.*

"Entirely soluble in muriatic acid, aided by gentle heat." *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—It is termed alterative, tonic, and emmenagogue. Its obvious effects on the body are very slight. It produces blackness of the stools; and in large doses occasions nausea, a sensation of weight at the pit of the stomach, and sometimes dyspeptic symptoms. It possesses very little astringency. The constitutional effects, arising from the continued use of it, are those produced by the ferruginous compounds generally, and which have been before described.

USES.—It may be employed in any of the before-mentioned caess in which the ferruginous tonics are indicated.

It has been strongly recommended by Mr. Benjamin Hutchinson[f] as a remedy for neuralgia, and in some cases it gives complete, in others partial, relief. But in many instances no benefit whatever is obtained from its use, and in one case in which I prescribed it the patient fancied it increased her sufferings. Mr. Carmichael, as already stated (p. 834), has recommended it as a remedy for cancerous diseases.

ADMINISTRATION.—The usual dose, as a tonic and emmenagogue, is from grs. x. to ʒss. In tic douloureux it is given in much larger quantities, as from ʒss. to ʒiij. or ʒiv. It may be administered in the form of an electuary. To enable it to sit easily on the stomach, it may be combined with aromatics.

EMPLASTRUM FERRI, E.; *Emplastrum Thuris*, D.; *Emplastrum Roborans; Iron, Frankincense*, or *Strengthening Plaster*. (Litharge Plaster, ℥iij.; Resin, ʒvj.; Olive Oil, fʒiijss.; Bees'-wax, ʒiij.; Red Oxide of Iron, ℥j. Triturate the oxide of iron with the oil, and add the mixture to the other articles previously liquefied by gentle heat. Mix the whole thoroughly, *Ed.*—Litharge Plaster, lbij.; Frankincense (*Thus*) lbss.; Red Oxide of Iron, ℥iij. M. *D.*) Spread on leather, it is employed as a mechanical support and slight stimulant, in muscular relaxation, lumbago, weakness of the joints, &c.

4. FER'RI SESQUIOX'YDUM HYDRA'TUM.—HYDRATED SESQUIOXIDE OF IRON.

(Ferrugo, *E.*)

HISTORY.—In the year 1834 this preparation was proposed by Drs. Bunsen and Berthold as an antidote for poisoning by arsenious acid[g].

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[e] *Journal de Chimie Méd.* t. vi. 2de Série, p. 646.

[f] *Cases of Tic Douloureux successfully treated*, 1820.

[g] Poggendorf, *Annalen d. Physik*, Bd. xxxii. S. 124. 1834; also, *Journal de Pharmacie*, xx. 567.

Preparation.—The Edinburgh Pharmacopœia gives the following directions for its preparation :—

Take of Sulphate of Iron, ℥iv. ; Sulphuric Acid (commercial), fʒiijss. ; Nitric Acid (D. 1380) fʒix. ; stronger Aqua Ammoniæ, f℥iijss. ; Water, Oij. Dissolve the sulphate in the water, add the Sulphuric Acid, and boil the solution ; add then the Nitric Acid in small portions, boiling the liquid for a minute or two after each addition, until it acquires a yellowish-brown colour, and yields a precipitate of the same colour with ammonia. Filter ; allow the liquid to cool ; and add in a full stream the Aqua Ammoniæ, stirring the mixture briskly. Collect the precipitate on a calico filter ; wash it with water till the washings cease to precipitate with nitrate of baryta ; squeeze out the water as much as possible ; and dry the precipitate at a temperature not exceeding 180°.

When this preparation is kept as an antidote for poisoning with arsenic, it is preferable to preserve it in the moist state, after being simply squeezed.

The sulphate of the protoxide of iron is converted, by the nitric and sulphuric acids, into the sulphate of the sesquioxide (see p. 835). On the addition of caustic ammonia, the hydrated sesquioxide of iron is precipitated, while sulphate of ammonia remains in solution. The oxide retains in combination with it some ammonia, but this does not prove injurious to its therapeutical use. If potash or soda be substituted for ammonia, we obtain, unless the alkali be in excess, a subsulphate, instead of the hydrated oxide of iron : and if we use excess of alkali, a portion of it combines with the oxide. Oxide which has been precipitated by potash has been found not to be equally efficacious as an antidote for arsenic, to that obtained by ammonia[h].

Properties.—Hydrated sesquioxide of iron has a deep reddish-brown colour. Prepared for use, as an antidote to arsenious acid, it should be in the form of a soft or gelatinous moist magma. Though it may be dried at ordinary temperatures without undergoing decomposition, yet, in this moist state, it more readily renders arsenious acid insoluble ; and, therefore, to preserve it in this condition, it should be kept under water in a stoppered bottle. If this hydrated sesquioxide (prepared by ammonia) be added in considerable excess to a solution of arsenious acid, and well agitated, the filtered liquor gives no traces of the presence of arsenic. Dr. Maclagan states that "at least twelve parts of oxide, prepared by ammonia, are required for each part of arsenic[i] ; and that when the oxide has either been precipitated by potash, or been dried even at a low temperature, that about three or four times larger quantities are requisite." That the arsenious acid has been rendered insoluble is shown by the fact that by washing it cannot be removed from the magma. In the first instance the arsenious acid combines with the sesquioxide of iron to form a subarsenite of the sesquioxide ; the composition of which Guibourt[j] approximatively represents as being, *sesquioxide of iron* (calcined to redness), 65·0; *arsenious acid*, 14·50; *water*, 20·50. According to Graham[k], the mutual reaction of the hydrated sesquioxide and the arsenious acid gives rise to the formation of the arseniate of the protoxide of iron, $2\,\mathrm{Fe}^2\mathrm{O}^3$ and $\mathrm{As}^2\mathrm{O}^3 = 4\,\mathrm{Fe\,O} + \mathrm{As}^2\mathrm{O}^5$. The same authority observes, that the constitution of this arseniate is probably $2\,\mathrm{Fe\,O.HO, As}^2\mathrm{O}^5 + 2\,\mathrm{Fe\,O}$.

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[h] See Bunsen's Memoir before quoted ; also Dr. Maclagan *On the Action of Hydrated Sesquioxide of Iron in Arsenic,* in the *Edinburgh Medical and Surgical Journal,* No. 144.

[i] "This proportion of twelve parts of the moist ammoniacal oxide to each part of arsenic, is that which has been indicated by several of the French experimentalists as being required to insure its antidotal effects."

[j] *Journal de Chimie Méd.* t. v. 2de Série, p. 312.

Composition.—It consists of *sesquioxide of iron*, *water*, and a small portion of *ammonia*. One hundred parts of the magma, deprived of water by decantation, yielded Guibourt from 3·2 to 3·5 of calcined sesquioxide. According to the same authority, 1 litre of the magma, equal to about $1\frac{3}{4}$ imperial pints (1.7608 imperial pints), contains 32·35 grammes or $499\frac{6}{10}$ troy grains (499·6134 troy grains) of the calcined sesquioxide. So that one imperial pint contains about 286 grains of the calcined sesquioxide.

Physiological Effects.—These are similar to those of the anhydrous sesquioxide before mentioned.

Uses.—The power of hydrated sesquioxide of iron to act as an antidote to arsenious acid is proved by three facts:—

α. It renders this poison insoluble.
β. Experiments on animals have shewn its efficacy as an antidote.
γ. In poisoning in the human subject it has proved successful.

I have already explained the nature of the reaction between arsenious acid and hydrated sesquioxide of iron, in virtue of which the former is rendered insoluble.

Drs. Bunsen and Berthold[l] were the first to shew that arsenious acid proved innocuous to animals when the hydrated sesquioxide was speedily administered. Their statements have been confirmed by the experiments of Soubeiran and Miquel[m], of Orfila and Lesueur[n], of Bouley, jun.[o], of Borelli and Demaria[p], of Dr. Mackenzie[q], of the Committee (composed of Drs. Deville, Nonat, and Sandras) appointed by the Société de Médecine of Paris[r], and of other experimentalists[s]. Opposed to this mass of evidence we have only the unfavourable results of Mr. Brett[t] and Mr. Orton[u]. But of these experimentalists I may remark, in the words of my friend Dr. Maclagan, that "with respect to the former, it may be observed, that he appears uniformly to have used too small quantities of the oxide; and the experiments of the latter hardly seem to have been made with sufficient care, as appears, in one instance at least, from his having injected both poison and antidote into the lungs instead of the stomach of the rabbit."

A very respectable testimony of the antidotal efficacy of the hydrated sesquioxide of iron in poisoning by arsenic, can now be adduced from its effects on man. In thirty-one cases[u] in which it was given, it proved successful in twenty-nine. In one of these nearly two drachms of arsenic had been taken[v]. In the two unsuccessful cases the antidote could not be retained on the stomach.

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[k] *Elements of Chemistry*, p. 636.
[l] *Op. cit.*
[m] *Journ. de Chim. Méd.* t. i. 2de Sér. p. 3.
[n] *Ibid.* p. 45.
[o] *Ibid.* p. 46.
[p] *Ibid.* p. 393.
[q] Quoted by Dr. Maclagan.
[r] *Journ. de Chim. Méd.* t. v. 2de Série, p. 317.
[s] Quoted by Dr. T. R. Beck in *Lond. Med. Gaz.* Oct. 15, 1841.
[t] *Lond. Med. Gaz.* vol. xv. p. 220.
[u] *Lancet*, Nov. 8, 1834.

It appears to me, therefore, that the threefold evidence of the antidotal power of this preparation is complete.

ADMINISTRATION.—The mode of administering this substance as an antidote in poisoning by arsenic has been already pointed out[w]. It must be especially remembered that very large doses of it are required to prove efficacious. It should, therefore, be given in the quantity of a tablespoonful every five or ten minutes, or as often as the patient can swallow it. If hydrated sesquioxide be not at hand, let the common red oxide of iron (see p. 837) be given with water as a substitute; for though not equally efficacious with the hydrated oxide, it appears to possess some antidotal power[x].

5. TINC'TURA FER'RI SESQUICHLO'RIDI, *L.*—TINCTURE OF SESCHLORIDE OF IRON.

(Ferri Muriatis Tinctura, *E.*—Muriatis Ferri Liquor, *D.*)

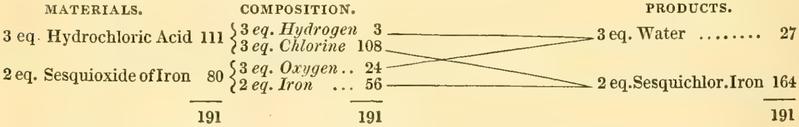
HISTORY.—This compound has been long in use, and is commonly termed the *Tincture of the Muriate of Iron.*

PREPARATION.—All the British Colleges give directions for its preparation:—

The *London* and *Edinburgh Colleges* order of Sesquioxide of Iron, ℥vj.; Hydrochloric Acid, Oj.; Rectified Spirit, Oiij. Pour the Acid upon the Sesquioxide of Iron in a glass vessel, and digest for three days, frequently shaking. Lastly, add the Spirit, and strain.

The *Dublin College* orders, of Rust of Iron, *one part;* Muriatic Acid; Rectified Spirit, of each, *six parts.* Pour the acid on the rust passed into a glass vessel, and occasionally stir the mixture during three days; then set it apart that the dregs may subside, and pour off the clear liquor: by slow evaporation reduce this to one-third part, and when cold add to it the spirit.

By digestion in hydrochloric acid the sesquioxide becomes the sesquichloride of iron, while water is formed.



As the sesquioxide of iron employed frequently contains a small portion of protocarbonate of iron, a little protochloride of iron is formed, and slight effervescence, owing to the escape of carbonic acid, takes place. Both the chlorides of iron are soluble in water as well as in spirit.

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[u] Dr. T. R. Beck, *op. cit.*

[v] *London Medical Gazette,* vol. xix. p. 177.

[w] See p. 648.

[x] See *Journn. de Chim. Méd.* t. v. 2^{de} Série, p. 305. et seq.

PROPERTIES.—This tincture is of a reddish brown colour, and stains white paper yellow. It has a sour styptic taste, and an odour of hydrochloric ether, from which it would appear that a mutual reaction takes place between the hydrochloric acid and the alcohol. It reacts on vegetable colours as an acid. "Its sp. gr. is about 0·992, and a fluidounce yields, when decomposed by potash, nearly 30 grains of sesquioxide of iron[y]."

Characteristics.—Its reaction on vegetable colours, its inflammability, its remarkable odour, its affording chloride of silver when treated by nitrate of silver, and its reaction, like the other ferruginous compounds (p. 829), are properties sufficient to characterize it. It forms a brown semitransparent jelly with mucilage of gum arabic.

COMPOSITION.—This tincture consists of *Rectified Spirit*, a small portion of *Hydrochloric Ether, Hydrochloric Acid, Sesquichloride of Iron*, and a little *Proto-chloride of Iron.* Unless excess of hydrochloric acid be present, sesquioxide of iron is thrown down when the tincture is exposed to the air, owing to the iron of the chloride attracting oxygen, and becoming sesquioxide.

Sesquichloride of iron has the following composition :—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*J. Davy.*
Iron	1	28	34·15	35·1
Chlorine	1½	54	65·85	64·9
Sesquichloride of Iron	1	82	100·00	100·0

PURITY AND STRENGTH.—The commercial tincture of sesquichloride of iron varies in its strength, owing to the varying density of the hydrochloric acid employed. Moreover, a diluted spirit is frequently substituted for rectified spirit. These differences can only be discovered by examining the colour and specific gravity of the tincture, as well as the quantity of oxide which it yields.

PHYSIOLOGICAL EFFECTS.—Tincture of sesquichloride of iron is, in its local action, one of the most powerful of the preparations of iron. It acts as an energetic astringent and styptic, and in large doses as an irritant. The large quantity of free hydrochloric acid which the tincture of the shops frequently contains, contributes to increase its irritant properties; and in Dr. Christison's *Treatise on Poisons* is a brief notice of a case in which an ounce and a half of this tincture was swallowed, and death occurred in about six weeks—the symptoms during life, and the appearances after death, being those indicative of inflammation of the alimentary canal. When swallowed in large medicinal doses it readily disorders the stomach. The general or constitutional effects of this preparation agree with those of other ferruginous compounds. It appears to possess, in addition, powerfully diuretic properties. Indeed it would seem to exercise some specific influence over the whole of the urinary apparatus; for on no other supposition can we explain the remarkable effects which it sometimes produces in affections of the kidneys, bladder, urethra, and even of the prostate gland. It colours the fæces black, and usually constipates the bowels.

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[y] Mr. R. Phillips, *Transl. of the Lond. Pharm.*

Uses.—It is sometimes, though not frequently, used as a topical agent. Thus it is applied as a *caustic* to venereal warts, and to spongy granulations. As an *astringent* it is sometimes employed as a local application to ulcers attended with a copious discharge; or as a *styptic* to stop hemorrhage from numerous small vessels.

Internally it may be employed as a *tonic* in any of the cases in which the other ferruginous compounds are administered, and which I have already mentioned. It has been especially commended in scrofula.

In various affections of the urino-genital organs it is frequently used with great success. Thus, in retention of urine, arising from spasmodic stricture, its effects are sometimes beneficial. It should be given in doses of ten minims every ten minutes until benefit is obtained, which frequently does not take place until nausea is excited. It has been used with success in this malady by Mr. Cline[z]; by Mr. Collins[a]; by Drs. Thomas, Eberle, and Francis[b]; and by Dr. Davy[c]. However, Mr. Lawrence[d], alluding to Mr. Cline's recommendation of it, observes, "I believe general experience has not led others to place any very great confidence in the use of this remedy." In gleet and leucorrhœa it is sometimes serviceable. I have found it occasionally successful, when given in conjunction with the tincture of cantharides, in the latter stage of gonorrhœa, after a variety of other remedies had failed. In passive hemorrhage from the kidneys, uterus, and bladder, it is likewise employed with benefit.

Administration.—The dose of it is from ten to thirty minims gradually increased to one or two drachms, and taken in some mild diluent.

Antidotes.—In a case of poisoning by it the treatment should be the same as for the mineral acids (see pp. 281 and 473).

6 FE′RRI AMMO′NIO-CHLO′RIDUM, *L.*—AMMONIO-CHLORIDE OF IRON.

History.—This compound, which was known to Basil Valentine, has had various appellations, such as *Flores Salis Ammoniaci martiales*, *Ferrum ammoniacale*, or *Ferrum ammoniatum.*

Preparation.—In the London Pharmacopœia it is directed to be thus prepared:—

Take Sesquioxide of Iron, ℥iij.; Hydrochloric Acid, Oss.; Hydrochlorate of Ammonia, lbijss.; Distilled Water, Oiij. Mix the sesquioxide of iron with the hydrochloric acid in a proper vessel, and digest them in a sand-bath for two hours; afterwards add the hydrochlorate of ammonia, first dissolved in the distilled water; strain and evaporate the liqour. Lastly, rub what remains to powder.

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[z] *Med. Records and Researches*, Lond. 1798.
[a] *Med. and Phys. Journ.* xvi. 250.
[b] *Eberle's Treat. on Mat. Med.* ii. 270, 2d ed.
[c] Paris's *Pharmacologia*, ii. 478, 6th ed.
[d] *Lond. Med. Gaz.* vi. 845.

By the mutual reaction of sesquioxide of iron and hydrochloric acid we obtain sesquichloride of iron and water, as explained at p. 842. A small portion of protochloride of iron will be produced if any carbonate of the protoxide of iron be mixed with the sesquioxide. By evaporating the solution thus procured with a solution of hydrochlorate of ammonia, we obtain a mixture of these bodies. There is no reason to believe that any chemical combination takes place.

PROPERTIES.—It is met with in the shops in the form of reddish orange-coloured crystalline grains, having a feeble odour and a styptic saline taste. It is deliquescent, and is soluble in both water and alcohol.

Characteristics.—Rubbed with quicklime or caustic potash, ammonia is evolved. Its solution affords chloride of silver when mixed with the nitrate of silver. It reacts as a persalt of iron (see p. 829).

COMPOSITION.—It is a mechanical mixture of hydrochlorate of ammonia and sesquichloride of iron, in the following proportions:—

	Per Cent.
Sesquichloride of Iron	15
Hydrochlorate of Ammonia	85
Ferri Ammonio-Chloridum, *Ph. L.*	100

It yields about 7 per cent. of sesquioxide of iron when decomposed by an alkali (Mr. R. Phillips).

The yellow bands sometimes found in cakes of hydrochlorate of ammonia are probably a true chemical compound of sesquichloride of iron and hydrochlorate of ammonia (vide p. 317).

Totally soluble in proof spirit and in water. Potash added to the solution throws down sesquioxide of iron; afterwards, when added in excess, it evolves ammonia. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS.—It produces the general effects of the ferruginous preparations; but, on account of the small and variable quantity of iron present, it is a compound which is of little value, The hydrochlorate of ammonia, which it contains, renders it alterative, and in large doses aperient.

USES.—It has been employed as a deobstruent in glandular swellings, in amenorrhœa, and other cases where the preparations of iron are usually employed.

ADMINISTRATION.—It may be given in substance in doses of from four to twelve or more grains.

TINCTURA FERRI AMMONIO-CHLORIDI, L. (Ammonio-Chloride of Iron, ℥iv.; Proof Spirit, Oj. M.)—"A fluidounce yields by decomposition 5·8 grains of sesquioxide of iron[e]." It should be expunged from the Pharmacopœia.

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[e] Phillips, *op. cit.*

7. FER'RI IO'DIDUM, *L. E.*—IODIDE OF IRON.

History.—We are indebted to Dr. A. T. Thomson for the introduction of this substance into medicine[f]. To distinguish it from other compounds of iodine and iron it is sometimes termed *Protiodide of Iron.* Other names for it are *Ioduret, Hydriodate* or *Iodohydrate of Iron.*

Preparation.—Directions for the preparation of this compound are given both by the London and Edinburgh Colleges.

The *London College* orders of Iodine, ℥vj.; Iron Filings. ℥ij.; Distilled Water, Oiβss. Mix the Iodine with four pints of the water, and to these add the Iron. Heat them in a sand-bath, and when it has acquired a greenish colour, pour off the liquor. Wash what remains with the half-pint of water, boiling. Let the mixed and strained liquors evaporate at a heat not exceeding 212° in an iron vessel, that the salt may be dried. Keep it in a well-stoppered vessel, access of light being prevented.

The Edinburgh College orders any convenient quantity of Iodine, Iron-wire, and Distilled Water in the proportions for making solution of Iodide of Iron [see *Ferri Iodidi Syrupus.*] Proceed as directed for that process; but before filtering the solution concentrate it to one-sixth of its volume, without removing the excess of iron-wire. Put the filtered liquor quickly in an evaporating basin, along with twelve times its weight of quicklime around the basin, in some convenient apparatus in which it may be shut accurately in a small space not communicating with the general atmosphere. Heat the whole apparatus in a hot air-press, or otherwise, until the water be entirely evaporated; and preserve the dry iodide in small well-closed bottles.

Fine soft iron-wire employed by the Edinburgh College is to be preferred to the iron filings used by the London College. It should be recently cleaned to free it from all rust.

In this process one equivalent or 126 parts of iodine combine with one equivalent or 28 parts of iron, and thereby form one equivalent or 154 parts of protiodide of iron.

The Edinburgh College directs a considerable excess of iron to be used. The object of this is to prevent the deposition of sesquioxide of iron (formed by the union of part of the iron of the iodide with the oxygen of the air) during the evaporation of the solution of the iodide. For the same reason also, the general atmosphere is directed to be excluded during the evaporation, which is ordered to be carried on over quicklime, in order that the latter may absorb the aqueous vapour.

Properties.—By evaporation with as little contact of air as possible, solution of iodide of iron yields green tabular crystals[g]. If the solution be evaporated to dryness and the residue be moderately heated, this salt is fused, and on cooling becomes an opaque, iron-grey crystalline mass, with a metallic lustre.

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[f] *Observat. on the Preparation and Medicinal Employment of the Ioduret and Hydriodate of Iron,* 1834.

[g] Mr. R. Phillips, *Translation of the Pharmacopœia.*

Iodide of iron has a styptic taste. It is fusible, volatile, very deliquescent, and very soluble in both water and alcohol. It readily attracts oxygen from the air, and is thereby converted into a mixture of sesquioxide and sesquiodide of iron. "A solution of protoiodide of iron dissolves iodine abundantly, becoming brown, and possibly containing the sesquiodide $Fe^2 I^3$, but it is more likely that the iodine is not combined, as it is sensible to the test of starch[h]."

Characteristics.—When heated in the air it evolves violet vapours of iodine, while the iron attracts oxygen from the air and is converted into sesquioxide. If this be dissolved in an acid (hydrochloric, nitric, or sulphuric), the liquid reacts as a solution of a persalt of iron (see p. 829). Alkalis throw down from it the reddish brown sesquioxide of iron. Solution of protiodide of iron, like that of other protosalts of iron, is green.

COMPOSITION.—The composition of crystallized iodide of iron is, according to Mr. R. Phillips, as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Iron	1	28	14
Iodine	1	126	63·3
Water	5	45	22·7
Hydrated Iodide of Iron	1	199	100·0

PURITY.—It should be perfectly soluble in water. By exposure to the air it forms sesquioxide and sesquiodide of iron[i]: the latter is soluble, the former is insoluble, in water. To preserve a solution of this salt, a coil of soft iron wire is to be kept immersed in it: this prevents the formation of sesquioxide of iron.

Emits violet vapours by heat, and sesquioxide of iron remains. When fresh prepared it is totally soluble in water. From this solution, when kept in a badly-stoppered vessel, sesquioxide of iron is very soon precipitated; but with iron wire immersed in it, it may be kept clear in a well-stoppered vessel. *Ph. Lond.*

Entirely soluble in water, or nearly so; forming a greenish solution. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Three drachms of iodide of iron were administered to a dog: vomiting and purging were produced, but in three days the animal was well. One drachm dissolved in a drachm of water killed a rabbit in three hours and a half, with the appearance of gradually-increasing debility: the stomach was found congested, and its lining membrane decomposed. Forty grains injected into the jugular vein of a dog killed the animal within twelve hours: the symptoms were dilatation of the pupils, staggering, vomiting, and bloody stools[ii].

β. On Man.—In *small and repeated doses* its effects are not very obvious, save that of blackening the stools. It sometimes sharpens the appetite and promotes digestion. It passes out of the system in the urine, and both of its constituents may be detected in this fluid. When it does not purge, it frequently acts as a diuretic. In *full doses*, as ten grains, it on one occasion caused uneasy sensation at the epigastrium, nausea, slight headache, copious black stool, and, in two hours, a larger quantity of urine, containing both iron and iodine[j]. Its medicinal influence on the body seems to be stimulant, tonic, and alterative or deobstruent. It possesses the combined properties of iron and iodine.

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[h] Kane, *Elements of Chemistry*, p. 732.

[i] Cogswell, *Essay on Iodine and its Compounds*, p. 128, et seq.

[ii] Sesqui-iodide of iron is said to produce the same effects, but to be more active than the iodide (*Lond. Med. Gaz.* June 18, 1841.)

USES.—Iodide of iron is indicated as a tonic and resolvent in cases of debility accompanied with a soft and relaxed condition of the solids, and paleness of the skin. It is especially applicable in scrofulous and strumous affections of the glandular system, in which the use both of iodine and iron is indicated.

In tabes mesenterica, and swellings of the cervical lymphatic glands, it often proves highly advantageous. In chlorosis, and in atonic amenorrhœa, Dr. Thomson found it serviceable; and his testimony of its good effects has been supported by that of others. Its operation must be promoted by exercise and an invigorating diet. In a case of anæmia, without any disturbance of the uterine function, I found it useless; while the compound iron mixture was of essential service. In secondary syphilis, occurring in debilitated and scrofulous subjects, it is in some cases, according to the testimony of both Dr. Thomson and Ricord[k], a valuable remedy. The last-mentioned writer employed it in the form of injection (composed of from half a drachm to a drachm of iodide dissolved in eight ounces of water) in blenorrhœas, and in that of lotion in venereal and carious ulcers. Dr. Pierquin[l] employed it internally and externally in leucorrhœa and amenorrhœa. It has also been used in incipient cancer and in atonic dyspepsia (Thomson).

ADMINISTRATION.—The dose of it is three grains gradually increased to eight or ten or more. Ricord has given forty grains per day. It may be exhibited in the form of tincture or of aqueous solution, flavoured with a little tincture of orange-peel. It must be remembered that acids, alkalis, and their carbonates, most metallic salts, all vegetable astringents, and many organic solutions, decompose it. Pierquin gave it in chocolate, Bourdeaux wine, distilled water, diluted spirit, or made into lozenges with saffron and sugar. In leucorrhœa and amenorrhœa he employed an ointment (composed of a drachm of iodide to an ounce of lard), by way of friction in the upper part of the thighs.

FERRI IODIDI SYRUPUS, E.—*Syrup of Iodide of Iron.* (Iodine, dry, 200 grs.; Fine Iron-wire, recently cleaned, 100 grs.; White Sugar, in powder, ℥ivss.; Distilled Water, f℥vj. Boil the iodine, iron, and water together in a glass matrass, at first gently to avoid the expulsion of iodine-vapour, afterwards briskly, until about two fluidounces of liquid remain. Filter this quickly, while hot, into a matrass containing the sugar. Dissolve the sugar with a gentle heat; and add distilled water, if necessary, to make up six fluidounces.—Twelve minims contain one grain of iodide of iron). This preparation is a very convenient form for the exhibition of iodide of iron, as it is not so readily decomposed as an aqueous solution of this salt[m]. In the Edinburgh Pharmacopœia it is described as being "colourless, or pale green; transparent; without sediment, even when exposed to the air."

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[j] Dr. A. T. Thomson, *op. cit.*

[k] *Journ de Pharm.* xxiii. 303.

[l] Quoted by Dierbach, *Neueste Entd. in d. Mat. Med.* 2te Ausg.

8. FER'RI SULPHURE'TUM, *E. D.*—SULPHURET OF IRON.

NATURAL HISTORY.—In the mineral kingdom sulphur and iron are frequently met with in combination. *Common Iron Pyrites*, commonly termed *Mundic*, is a bisulphuret of iron. *White Iron Pyrites*, or *Cockscomb Pyrites*, differs from mundic in its specific gravity, the shape of its crystal, and its tendency to decompose on exposure to the air, and thereby to furnish sulphate of iron. *Magnetic Iron Pyrites* contains a less proportion of sulphur.

PREPARATION.—Directions for the preparation of sulphuret of iron are given in both the Edinburgh and Dublin Pharmacopœias.

The *Edinburgh College* states that "the best sulphuret of iron is made by heating an iron rod to a full white heat in a forge, and rubbing it with a roll of sulphur over a deep vessel filled with water, to receive the fused globules of sulphuret which form. An inferior sort, good enough, however, for pharmaceutic purposes, is obtained by heating one part of sublimed sulphur and three of iron filings in a crucible in a common fire till the mixture begins to glow, and then removing the crucible and covering it, until the action, which at first increases considerably, shall come to an end."

The *Dublin College* direct, that a rod of iron should be exposed to the strongest heat of a forge, until it becomes white hot, and, when taken from the fire, let it instantly be applied to a solid mass of sulphur. Let the sulphuret of iron be received in water; and, when separated from the sulphur and dried, let it be preserved in closed vessels.

The sulphur and iron enter into combination, and form sulphuret of iron.

PROPERTIES.—The appearance of sulphuret of iron varies somewhat according to the mode of procuring it. If properly prepared it gives out abundance of sulphuretted hydrogen gas, when mixed with either diluted sulphuric or muriatic acid, while a ferruginous solution is obtained.

COMPOSITION.—Its composition is liable to some variation. The best is a protosulphuret of iron, and consists of 1 equivalent or 10 parts of *sulphur*, combined with 1 equivalent or 28 parts of *iron*. Sometimes, however, a compound containing a larger proportion of sulphur is found.

USES.—It is employed as the source of sulphuretted hydrogen (see p. 478).

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[m] For some observations on the chemical properties of Syrup of Iodide of Iron, see Wackenroder in the *Pharmaceutisches Central-Blatt für* 1839, S. 628. See also some remarks on *Ioduretum Ferri Saccharatum*, by Kerner, in *Berlinisches Jahrbuch für die Pharmacie*, Bd. xlii. S. 212, 1839.

9. FER'RI FER'RO-SESQUICYAN'IDUM.—FERRO-SESQUICYANIDE OF IRON.

(Ferri Percyanidum, *L.*—Ferri Cyanuretum, *D.*)

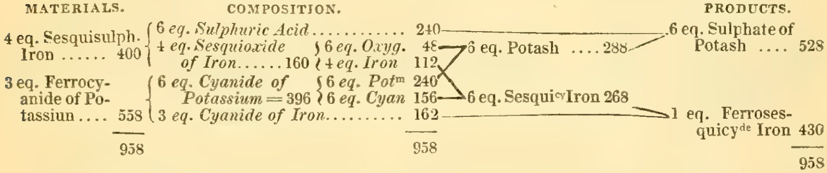
History.—This compound was accidentally discovered at the commencement of the last century by Diesbach and Dippel. It was termed *Prussian* or *Berlin Blue* (*Cæruleum Borussicum* seu *Berolinense*). It is sometimes termed *Ferroprussiate of Iron.*

Preparation.—It is sometimes prepared by mixing a solution of persulphate or perchloride of iron with a solution of ferrocyanide of potassium.

In commerce it is procured by adding a mixture of two parts of alum and one of sulphate of iron to an impure solution of ferrocyanide of potassium (called blood-lye or *lixivium sanguinis*). A dingy-green precipitate falls, which, by repeated washing with very dilute hydrochloric acid, and exposure to the air, becomes gradually of a deep blue. It is then collected and drained on a cloth, and afterwards dried.

By the reaction of ferrocyanide of potassium on sulphate of the protoxide of iron, sulphate of potash is formed in solution, and a white precipitate subsides, which, by exposure to the air, becomes blue (see p. 851). Ferrocyanide of potassium, with sulphate of the sesquioxide of iron, forms sulphate of potash and ferrosesquicyanide of iron. Commercial Prussian blue contains alumina (derived from the alum), and usually some sesquioxide of iron.

The following diagram illustrates the reaction of ferrocyanide of potassium on sulphate of the sesquioxide of iron:—


MATERIALS.
COMPOSITION.
PRODUCTS.
4 eq. Sesquisulph. Iron 400
6 eq. Sulphuric Acid 240
4 eq. Sesquioxide of Iron 160
6 eq. Oxyg. 48
4 eq. Iron 112
3 eq. Ferrocyanide of Potassiun 558
6 eq. Cyanide of Potassium = 396
6 eq. Potm 240
6 eq. Cyan 156
3 eq. Cyanide of Iron 162
958
958
6 eq. Potash 288
6 eq. Sesquicy Iron 268
6 eq. Sulphate of Potash 528
1 eq. Ferrosesquicyde Iron 430
958

Properties.—Prussian blue occurs in masses of a rich dark blue colour. It is tasteless and inodorous. When broken it has a copper or bronze tint, somewhat like that of indigo, but which is distinguished from that of the latter by its being removed by rubbing with the nail. It is insoluble in water, alcohol, and the diluted mineral acids. Strong sulphuric acid forms with it a white pasty mass, from which water again separates Prussian blue. Both nitric acid and chlorine decompose it. Hydrochloric acid abstracts part of its iron.

Characteristics.—Its colour and copper tint above described form part of its characteristics. Boiled with water and binoxide of mercury it yields bicyanide of mercury (see p. 765). Boiled with solution of potash it forms ferrocyanide of potassium. Heated in a retort it yields water, hydrocyanate of ammonia, then carbonate of ammonia, and leaves a black, carbonaceous, and ferruginous mass.

The blue precipitate which falls when red prussiate of potash is added to a protosalt of iron, is called TURNBULL'S BLUE. It consists of 5 eq. Iron and 6 eq. Cyanogen; or 3 eq. Protocyanide of Iron and 2 eq. Sesquicyanide of Iron. Liebig calls it *Ferridcyanide of Iron.* It is distinguished from Prussian blue by the circumstance that when boiled in a solution of yellow prussiate of potash, it affords red prussiate of potash, which dissolves, and a grey insoluble residue of ferrocyanide of iron and ferrocyanide of potassium.

BASIC PRUSSIAN BLUE, or the *Basic Sesquiferrocyanide of Iron,* is a compound of 1 eq. Prussian Blue and two equivalents of Sesquioxide of Iron. It is soluble in water. It is formed by exposing *ferrocyanide of potassium and iron* (the bluish white precipitate formed when yellow prussiate of potash is added to a protosalt of iron) to the air. Oxygen is absorbed, and two products are obtained—viz. Basic Prussian Blue and Yellow Prussiate of Potash. 2 eqs. of Ferrocyanide of Potassium and Iron $Fe^{10}\ Cy^{12}\ K_2$), with 3 eqs. Oxygen (O_3), yield 1 eq. Yellow Prussiate of Potash ($Fe\ Cy^3\ K^2$), 1 eq. Prussian Blue ($Fe^7\ Cy_9$), and 2 eqs. Sesquioxide of Iron ($Fe^2\ O^3$).

COMPOSITION.—The following is the composition of pure and anhydrous Prussian blue:—

	Atoms.	*Eq.Wt.*	*Per Ct.*			*Atoms.*	*Eq.Wt.*	*Per Ct.*
Iron	7	196	45·5	or	Protocyanide of Iron	3	162	37·8
Cyanogen	9	234	54·5		Sesquicyanide of Iron	4	268	62·2
Ferrosesquicyanide of Iron	1	430	100·0			1	430	100·0

Prussian blue appears to contain also the elements of water, of which it cannot be deprived without the destruction of the compound.

PURITY.—Prussian blue of commerce usually contains alumina and sesquioxide of iron. These may be detected by boiling the suspected compound with diluted hydrochloric acid, which dissolves both the impurities. Caustic ammonia added to the filtered solution throws down the impurities; excess of the alkali will redissolve the alumina.

It is pure if, after being boiled with dilute hydrochloric acid, ammonia throws down nothing from the filtered solution. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *α. On Animals.*—Coullon gave it to dogs and sparrows without killing them; and Schubarth states that the only effect produced on a dog by two drachms was dejection[n].

β. On Man.—Its effects on man are not very obvious. It is reputed alterative, tonic, and febrifuge. Sachs[o] calls it a resolvent tonic.

USES.—It has been recommended by Dr. Zollickoffer[p] as a more certain, prompt, and efficacious remedy for intermitting and remitting fevers than cinchona; and particularly adapted for children, on account of its insipidity and smallness of dose. It may be administered during the paroxysm as well as in the intermission, and does not disagree with the most irritable stomach. Hosack[q], Eberle[r], and others, have borne testimony to its good effects. Subsequently, Zollickoffer found it useful in dysentery. Kirkhoff[s] used it for many years in epilepsy, with the best results, having cured some cases of several years' standing. It has also been employed by Dr. Bridges, of Philadelphia[t], in a case of severe and protracted facial neuralgia, with very considerable relief. Lastly, it has been used in the form of ointment, as an application to foul ulcers.

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[n] Wibmer, *Wirk. d. Arzneim,* ii. 356.

[o] *Handwört. d. prakt. Arzneim,* ii. 557.

[p] *Treatise on the Use of Prussian Blue in Intermitting and Remitting Fevers,* Maryland, 1822.

In pharmacy it is employed in the manufacture of bicyanide of mercury.

ADMINISTRATION.—The dose of commercial Prussian blue is from four to six or more grains every four hours. The *ointment* above referred to may be prepared with a drachm of Prussian blue and an ounce of lard.

10. POTAS'SII FERROCYAN'IDUM, *L. E.*—FERROCYANIDE OF POTASSIUM.

HISTORY.—This salt was accidentally discovered at the commencement of the last century. It has had a variety of appellations, such as *Prussiate of Potash*, *Ferroprussiate of Potash*, and *Ferrocyanate of Potash*.

PREPARATION.—The usual method of obtaining it is the following:—"Into an egg-shaped iron pot, brought to moderate ignition, project a mixture of good pearl-ash and dry animal matters, of which hoofs and horns are the best, in the proportion of two parts of the former to five of the latter. Stir them well with a flat iron paddle. The mixture, as it calcines, will gradually assume a pasty form, during which transition it must be tossed about with much manual labour and dexterity. When the conversion into a chemical compound is seen to be completed by the cessation of the fœtid animal vapours, remove the pasty mass with an iron ladle. If this be thrown, while hot, into water, some of the Prussic acid will be converted into ammonia, and of course the usual product diminished. Allow it to cool, dissolve it in water, clarify the solution by filtration or subsidence, evaporate, and, on cooling, yellow crystals of the ferroprussiate of potash will form. Separate these, re-dissolve them in hot water, and by allowing the solution to cool very slowly, larger and very regular crystals may be had[u]."

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[q] *New York Medical and Physiological Journal*, 1823, quoted by Richter, *Ausf. Arzneim.*

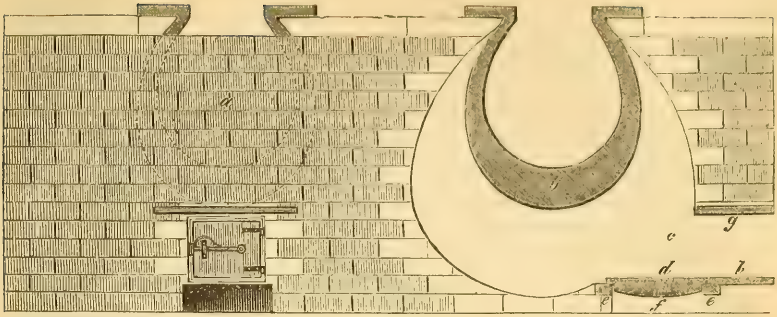
[r] *Mat. Med.* i. 233.

[s] Froriep's *Notizen*, Bd. xvij. 340.

[t] *United States Dispensatory.*

[u] Ure's *Dictionary of Chemistry.*

FIG. 128.



Egg-shaped Iron Pots and Furnaces used for the manufacture of Ferrocyanide of Potassium.

a. Front view of furnace, with pot.	*e. e.* Bearing bars.
b. Section of pot *in situ.*	*f.* Ash-pit.
c. Fire-place.	*g.* Bearing plate.
d. Fire bar.	*h.* Dead plate.

"Mr. Charles Mackintosh, of Glasgow, who is one of the largest manufacturers of this salt, informs me that the animal matters employed as the source of cyanogen are chiefly chips of horns, animal hoofs, woollen rags, and the substance called *greaves*, which is the refuse of tallow-melters, and consists chiefly of cellular membrane from which the fat has been expressed: these are burned, and in fact, fused at a very high heat with potash, to form what is called *prussiate cake;* this, when cold, is lixiviated with water, and the evaporated solution yields a first crop of very impure ferroprussiate; it is redissolved, and the second crystallization is allowed to go on very slowly, it being at least a fortnight before the contents of the coolers are disturbed. The iron requisite to the constitution of this salt is derived from the iron pots and stirrers used in the operation, or, if requisite, iron filings are added" (Brande).

The following explanation of the theory of this process is from Liebig[v]. When animal substances containing carbon and nitrogen are fused with potash at a red heat, the potassium is reduced by the carbon, and forms by its reaction on the other ingredients cyanuret of potassium. The fused mass at a red heat contains no ferrocyanogen, but iron and carburet of iron in the form of a suspended powder. When it is lixiviated with cold water and immediately evaporated, it furnishes no ferrocyanuret; but when the solution is gently heated for several hours in the contact of air, oxygen is absorbed, it acquires a yellow colour, and now contains much ferrocyanuret of potassium. This explains why a solution of cyanuret of potassium in pure water and in the presence of finely-divided metallic iron, absorbs the oxygen of the air in passing into the state of oxide of potassium and dissolving the metal; the potassium of the cyanuret, in yielding to the iron the cyanogen with which it was combined, and so forming cyanuret of iron, enables it to combine with the remaining undecomposed cyanuret of potassium to form ferrocyanuret of potassium. In close vessels the solution of iron by cyanuret of potassium evolves hydrogen. The fused mass also contains free potassa, which, by being boiled with the cyanuret of potassium, decomposes it into formiate of potassa and ammonia. When animal substances are fused in open vessels with potassa, cyanate of potassa is formed, which is decomposed by boiling into ammonia and bicarbonate of potassa; the quantity of ammonia formed being in proportion to the loss of cyanuret of potassium.

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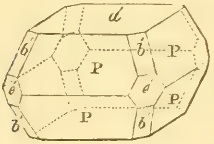
[v] See *Phil. Mag.* for June, 1841; also *Proceedings of the Chemical Society*, p. 2.

The best way of converting the whole of the cyanuret into ferrocyanuret of potassium, is to treat one-third of a cold solution of the raw mass with protosulphate of iron, as long as a precipitate falls, and then to add the remaining two-thirds of the solution, and heat the whole to the boiling point; the solution may then be evaporated without decomposition, and the sulphate of potassa is easily separated by crystallization from the ferrocyanuret. The original solution of the fused mass generally contains sulphuret and sulphocyanuret of potassium, and formiate and carbonate of potassa, which remain in the mother liquor (Brande).

Mr. L. Thompson has observed that cyanuret of potassium is abundantly formed when an ignited mixture of coke or charcoal, carbonate of potassa, and iron-filings, is exposed to the action of the air. In that process he says the potassa is decomposed by the iron, and that the evolved potassium combines with the carbon, and also with the nitrogen of the atmosphere; and that the cyanuret of potassium results from this action. He proposes to apply the process to the manufacture of Prussian blue [w] (Brande).

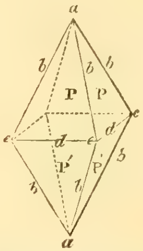
PROPERTIES.—This salt crystallizes in large, beautiful, lemon-yellow, transparent, permanent, inodorous, tabular crystals, whose form is the octohedron with a square base, usually more or less truncated.

FIG. 129.



Truncated octohedron of ferrocyanide of potassium.

FIG. 130.



Octohedron (primary form) of ferrocyanide of potassium.

They have a peculiar toughness or flexibility somewhat analogous to selenite. Their sp. gr. is 1·832. They have a sweetish, yet somewhat bitter, saline taste. They are insoluble in alcohol, but dissolve readily in both hot and cold water. When moderately heated they evolve about 13 per cent. of water of crystallization, and are converted into a white friable powder (anhydrous ferrocyanide of potassium). When heated to redness in contact with air, the cyanide of iron of the salt is decomposed, and the residuum consists of cyanide of potassium, oxide of iron, and carbon: by a more continued heat hydrocyanic acid and ammonia are evolved, while the residue consists of sesquioxide of iron and carbonate of potash.

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[w] *Trans. Soc. Arts,* lii. 24.

Characteristics.—A solution of this salt throws down, with the protosalts of iron, a white precipitate (*ferrocyanide of potassium and iron*, see p. 851), which by exposure to the air becomes blue (*Basic Prussian Blue*, see p. 851). With the persalts of iron it forms a deep blue (*Prussian Blue*); with the salts of copper a deep brown (*Ferrocyanide of Copper*); and with those of lead a white precipitate (*Ferrocyanide of Lead*). Heated with dilute sulphuric acid, hydrocyanic acid is evolved, and a white precipitate formed, which, by exposure to the air, becomes blue. Hydrosulphuric acid, the sulphurets, alkalis, or tincture of galls, give no precipitate with a solution of this salt; showing that the iron which it contains is in some remarkable state of combination. If a solution of the ferrocyanide of potassium be boiled with binoxide of mercury, bicyanide of mercury is formed in solution, and a mixture of sesquioxide and cyanide of iron is precipitated. The presence of potassium is best shown by calcining the salt, and detecting potash by the usual tests in the residuum. If chlorine be passed through a solution of ferrocyanide of potassium, it abstracts one equivalent of potassium from every two equivalents of the ferrocyanide, by which one equivalent of the ferrosesquicyanide of potassium (*Red Prussiate of Potash*) is formed in solution, and by evaporation this salt may be obtained in the form of red crystals, which throw down a blue precipitate (*Turnbull's Blue*, see p. 851) with the protosalts of iron, but occasion no change with the persalts of iron.

COMPOSITION. — Crystallized ferrocyanide of potassium has the following composition :—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Or,*	*Atoms.*	*Eq.Wt.*	*Per Cent.*
Cyanogen	3	78	36·620	Cyanide of Iron	1	54	25·35
Iron	1	28	13·145	Cyanide of Potassium	2	132	61·97
Potassium	2	80	37·560	Water	3	27	12·67
Water	3	27	12·675				
Cryst^{d}. Ferrocyanide Potassium	1	213	100·000		1	213	99·99

Totally dissolved by water. A gentle heat evaporates 12·6 parts from 100 parts. It slightly [if at all] alters the colours of turmeric. What it throws down from the preparation of sesquioxide of iron is blue, and that from the preparations of zinc is white. When burnt, the residue dissolved by hydrochloric acid is again thrown down by ammonia; 18·7 parts of sesquioxide of iron are yielded by 100 parts. *Ph. Lond.*

PHYSIOLOGICAL EFFECTS. *a. On Animals.* — Schubarth[x] gave two drachms to one dog, and half an ounce to another, without observing any injurious consequences. Callies[y] found the commercial ferrocyanide of potassium slightly poisonous, but when prepared with care he remarked that several ounces might be given with impunity. These and other experiments show that this salt possesses very little activity. The rapidity with which it is absorbed and gets into the secretions, as the urine, is most remarkable. Westrumb[z] recognised it in the urine, in from two to ten minutes after it was taken into the stomach. Hering[a] has shown the amazing rapidity with which it traverses the body when it once gets into the blood. Thus, when it was placed in one jugular vein of a horse, he recognised it in the opposite one in from twenty to thirty seconds.

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[x] Wibmer, *Wirk. d. Arzneim.*

[y] Wibmer, *op. cit.*; also Christison's *Treat. on Poisons.*

[z] Müller's *Physiology*, by Baly, i. 247.

β. On Man.—It has no great influence on man. D'Arcet swallowed half a pound of a solution of this salt, prepared as a test, without any ill effects[b]. "Similar results," observes Dr. Christison[c], "were obtained previously with smaller doses by Wollaston, Marcet, Emmert, as well as afterwards by Dr. Macneven and Schubarth, who found that a drachm or even two drachms might be taken with impunity by man and the lower animals."

Dr. Smart[d], however, regards it as possessed of some activity. He asserts that its primary action is that of a sedative, softening and diminishing the fulness and frequency of the pulse, and allaying pain and irritation. In a healthy person, he says, a full dose will often reduce the number of pulsations ten beats in a minute, in a few minutes after being taken; and in a diseased state of the system, accompanied with increased arterial action, the sedative effects are much more striking. Occasionally also it acts as a diaphoretic (in cases accompanied with excessive vascular action and increased heat of skin) and astringent, as seen in its power of diminishing excessive discharges. In some cases, he says, it caused ptyalism, with redness, swelling, and tenderness of the gums, but unaccompanied with swelling of the salivary glands or fœtor. An over-dose, he tells us, occasions vertigo, coldness, and numbness, with a sense of gastric sinking; sometimes universal tremors, as in an ague fit. Further evidence, however, is required to confirm these statements, which do not accord with the observations before reported.

USES.—Hitherto it has rarely been employed in medicine. Dr. Smart employed it as a sedative in diseases of increased action of the vascular system and morbid sensibility of the nerves, as in erysipelas, to allay pain, in cephalalgia, in inflammation of the brain, in chronic bronchitis, &c. In the last-mentioned disease it lessened the frequency of pulse, the sweating, the cough, and the dyspnœa. As an anodyne, he gave it in neuralgia. In hooping-cough he speaks highly of it. As an astringent, he administered it to check colliquative sweating in chronic bronchitis and phthisis, to diminish leucorrhœal discharge and to allay diarrhœa. Rau[e] employed it in calculous complaints.

ADMINISTRATION.—The dose, according to Dr. Smart, is from ten to fifteen grains, given in the form of solution every four or six hours. Rau gave as much as forty grains at a dose, and I have no doubt that very much larger doses may be given with safety.

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[a] *Lond. Med. Gaz.* iv. 250.

[b] Merat and De Lens, *Dict. Mat. Med.* ii. 532.

[c] *Treatise.* p. 699.

[d] *Amer. Journ. of Med. Sciences.* xv. 362.

[e] Dierbach, *Neueste Entd. in d. Mat. Med.* i. 371. 1837.

11. FER'RI SUL'PHAS, *L. E. D.*—SULPHATE OF IRON.

History.—Sulphate of iron is one of the substances which Pliny[f] termed *Chalcanthum*. This is evident from the circumstance of his statement that the Romans called it *Atramentum Sutorium*, or *Shoemaker's Black*. It is frequently termed *Copperas*, and in consequence has been sometimes confounded with the salts of copper[g]: *Green Vitriol* (*Vitriolum Viride*), *Vitriol of Mars* (*Vitriolum Martis*), *Salt of Mars* (*Sal Martis*), *Vitriolated Iron* (*Ferrum Vitriolatum*), are other names by which it is known.

Natural History.—It is found dissolved in some mineral waters, (*sulphated chalybeates*, vide p. 266), as those of the Hartfell Spa, Scotland. In the *aluminous chalybeate* waters it is associated with sulphate of alumina; as in the water of Sand Rock, Isle of Wight. The strong Moffatt chalybeate, and Vicar's Brig chalybeate, contain the sulphate of the sesquioxide of iron. Sulphate of iron is also found in the waters of several copper mines.

Sulphate of the protoxide of iron is rarely met native in the crystallized state. It occurs, however, in Rammelsberg mine, near Goslar; at Schwartzenburg, in Saxony; at Hurlet, near Paisley; and in New England[h].

Dr. Thomson[i] has described two native sulphates of the sesquioxide of iron, and an aluminous protosulphate.

Preparation.—Sulphate of the protoxide of iron is prepared by dissolving clean unoxidized iron in diluted sulphuric acid.

The *London College* orders, of Iron Filings, ℥viij.; Sulphuric Acid, ℥xiv.; Water, Oiv. Mix the Sulphuric Acid with the Water, and add the Iron to them; then apply heat, and when bubbles have ceased to escape, strain the liquor, and set it aside that crystals may be formed. Evaporate the liquor poured off, that it may again yield crystals. Dry them all.

The *Edinburgh College* observes, that if the Sulphate of Iron of commerce be not in transparent green crystals, without efflorescence, dissolve it in its own weight of boiling water, acidulated with a little sulphuric acid; filter, and set the solution aside to crystallize. Preserve the crystals in well-closed bottles.

The *Dublin College* orders, of Iron Wire, *four parts*; Sulphuric Acid, *seven parts*; Water, *sixty parts*.

In this process an equivalent or 28 parts of iron decompose one equivalent or 9 parts of water, combining with an equivalent or 8 parts of oxygen, and setting free an equivalent or 1 part of hydrogen, which escapes in the gaseous form. The equivalent or 36 parts of protoxide iron, thus formed, combines with an equivalent or 40 parts of sulphuric acid, to form an equivalent or 76 parts of sulphate of iron.

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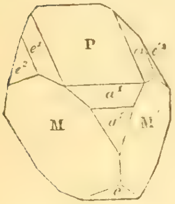
[f] *Hist. Nat.* xxxiv. 32.
[g] Dr. Cummin, *Lond. Med. Gaz.* xix. 40.
[h] Phillip's *Mineralogy*, by Allan.
[i] *Outlines of Mineralogy*, vol. i.

MATERIALS.			PRODUCTS.
1 eq. Water 9	1 eq. *Hydrogen* 1		1 eq. Hydrogen...... 1
	1 eq. *Oxygen*.. 8	1 eq. Protoxide Iron 36	
1 eq. Iron 28			
1 eq. Sulphuric Acid 40			1 eq. Sulphate of Iron 76
77			77

The *Common Green Vitriol*, or *Copperas* of the shops, is prepared by exposing heaps of moistened iron pyrites (bisulphuret of iron) to the air for several months. In some places the ore is previously roasted. The moistening is effected by rain or by manual labour. The pyrites attracts oxygen, and is converted into a supersulphate of iron, which is dissolved out by lixiviation; and to the solution thus obtained old iron is added to saturate the free acid. It is then concentrated in leaden boilers, and run off into large vessels (lined with lead) to crystallize.

Fig. 131.



Crystal of Sulphate of Iron.

Properties.—Sulphate of the protoxide of iron crystallizes in transparent pale bluish green crystals, the form of which is the oblique rhombic prism. Their sp. gr. is 1·82. They have an acid, styptic taste, and redden litmus. By exposure to the air oxygen is absorbed, and they acquire, first, a yellowish and darker green tint, then slightly effloresce, and become covered with a yellow crust, which subsequently changes to brownish (*sulphate of the sesquioxide of iron*). When heated the crystals undergo the watery fusion, give out water, and become white and pulverulent: at an intense heat they are deprived of their acid. They are soluble in water, but insoluble in alcohol. They require two parts of cold, and three-fourths of their weight of boiling water, to dissolve them. The solution has a bluish green colour, but by exposure to the air it attracts oxygen, becomes reddish yellow, and deposits a tetrasulphate of the sesquioxide of iron.

Characteristics.—It is known to be a sulphate by chloride of barium (see p. 469). Binoxide of nitrogen communicates a deep olive colour to a solution of this salt (vide p. 288). Ferrocyanide of potassium causes a white precipitate (*ferrocyanide of potassium and iron*, see p. 851), which, by exposure to the air, becomes blue (*Basic Prussian Blue*). If any sesquioxide be present, a bluish precipitate (*Prussian Blue*) is obtained. Alkalis throw down the greenish white hydrated protoxide of iron.

Composition.—The composition of this salt is as follows:—

	Atoms.	*Eq.Wt.*	*Per Cent.*	*Berzelius.*	*Thomson.*
Protoxide of Iron	1	36	25·9	25·7	26·7
Sulphuric Acid	1	40	28·8	28·9	28·3
Water	7	63	45·3	45·4	45·0
Crystallized Sulphate of the Protoxide of Iron	1	139	100·0	100·0	100·0

Purity.—This salt is frequently mixed with sulphate of the sesquioxide: this may be known by the yellowish green colour of the crystals, and by the blue colour produced on the addition of ferrocyanide of potassium.

Colour bluish green; dissolved by water. Iron put into the solution does not precipitate copper. *Ph. Lond.*

Pale bluish green crystals, with little or no efflorescence. *Ph. Edinb.*

The *Common Green Vitriol*, or *Copperas* of the shops, is a mixture of the sulphates of the protoxide and sesquioxide of iron. It sometimes contains copper, which may be recognised by immersing a clean iron spatula in a solution of it; the iron becomes encrusted with copper: or it may be detected by adding excess of caustic ammonia, and filtering the liquor. If copper be present, the liquor will have an azure blue tint. The ammoniacal liquid should yield, by evaporation, no fixed residuum.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Sir H. Davy[j] ascribes the sterility of a soil to the presence of sulphate of iron.

β. *On Animals.*—C. G. Gmelin[k] found that two drachms of sulphate of iron given to a dog caused vomiting only; that forty grains had no effect on a rabbit; and that twenty grains, thrown into the jugular vein of a dog, produced no effect. Dr. Smith[l], however, found that two drachms proved fatal to a dog when taken into the stomach or applied to a wound. Orfila[m] obtained similar results. The effects were local inflammation and a specific affection of the stomach and rectum. According to Weinhold[n], the spleen of animals fed with it becomes remarkably small and compact.

γ. *On Man.*—This salt acts locally as a powerful astringent, and, when employed in a concentrated form, as an irritant. The latter effect depends on its chemical action on the organic constituents (albumen, &c.) of the tissues. The remote effects of sulphate of iron are analogous to those of other ferruginous compounds, and which have been already described.

Swallowed *in small doses* it has an astringent operation on the gastro-intestinal mucous membrane, and thereby diminishes the quantity of fluids secreted or exhaled: hence its continued use causes constipation. It blackens the stools like other compounds of iron. It becomes absorbed, and operates on the system as a tonic, stimulant, emmenagogue, and astringent. *In large medicinal doses* it readily excites pain, heat, or other uneasiness at the pit of the stomach, and not unfrequently causes nausea and vomiting: this is especially the case in irritable conditions of this viscus. *In excessive doses* it operates as an irritant poison. A girl took, as an emmenagogue, an ounce of it in beer, and was seized, in consequence, with colic pains, constant vomiting and purging for seven hours. Mucilaginous and oily drinks soon cured her[o].

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[j] *Agricult. Chem.* 4th ed. 186.

[k] *Vers. u. d. Wirk.* &c. 84.

[l] Quoted by Wibmer and by Christison.

[m] *Toxicol. Gén.*

[n] Quoted by Richter, *Ausf. Arzneim.* v. 55.

[o] Christison, from Rust's *Magazin*, xxi. 247.

Uses.—Sulphate of iron is to be preferred to other ferruginous compounds where there is great relaxation of the solid parts with immoderate discharges. Where the long-continued use of ferruginous compounds is required, it is less adapted for administration than some other preparations of iron, on account of its local action on the alimentary canal.

It is employed in lump, powder, or solution, as a styptic, to check hemorrhage from numerous small vessels. A solution of it is applied to ulcerated surfaces, and to mucous membranes, to diminish profuse discharges; as in chronic ophthalmia, leucorrhœa, and gleet.

Internally it is administered in passive hemorrhages, on account of its supposed astringent influence over the system generally: also in immoderate secretion and exhalation; as in humid asthma, chronic mucous catarrh, old dysenteric affections, colliquative sweating, diabetes, leucorrhœa, gleet, &c. In intermittents it has been employed as a tonic. It has also been found serviceable against tape-worm. Its other uses are the same as the ferruginous compounds before mentioned.

Administration.—The dose of it is from one to five grains, in the form of pill. If given in solution the water should be recently boiled, to expel the atmospheric air dissolved in it; the oxygen of which converts this salt into a persulphate. For local purposes, solutions of it are employed of various strengths, according to circumstances. In chronic ophthalmia we may use one or two grains to an ounce of water: as an injection in gleet, from four to ten grains.

1. **FERRI SULPHAS EXSICCATUM,** E.; *Dried Sulphate of Iron.*—(Expose any convenient quantity of Sulphate of Iron to a moderate heat in a porcelain or earthenware vessel, not glazed with lead, till it is converted into a dry greyish white mass, which is to be reduced to powder).—By exposure to a moderate heat the crystals lose $\frac{6}{7}$ths of their water of crystallization; so that 85 grains of dried sulphate are equivalent to 139 grs. of the crystallized sulphate; or 3 grains are equal to $4\frac{9}{10}$ grs. of the crystals. The dried sulphate is used in the following preparation.

2. **PILULÆ FERRI SULPHATIS,** E.; *Pills of Sulphate of Iron.*—(Dried Sulphate of Iron, *two parts;* Extract of Taraxacum, *five parts;* Conserve of Red Roses, *two parts;* Liquorice-root powder, *three parts.* Beat them together into a proper mass, which is to be divided into five-grain pills).—Each pill should contain $\frac{5}{6}$ of a grain of dried sulphate of iron.—Dose, one to three pills.

12. FER'RI CAR'BONAS.—CARBONATE OF IRON.

History.—This compound must not be confounded with the sesquioxide of iron, which is frequently but improperly termed carbonate of iron (see p. 838).

Natural History.—It occurs native in the crystallized state, constituting the mineral called *Spathose Iron.* It is also found in the *carbonated chalybeate waters* (see p. 266).

PREPARATION.—It is prepared by adding a solution of an alkaline carbonate to a solution of a protosalt (as the sulphate) of iron, the atmospheric air being carefully excluded. The carbonate of the protoxide of iron is precipitated. When we attempt to collect and dry it, decomposition takes place; oxygen of the air is absorbed, carbonic acid escapes, and sesquioxide of iron remains (see *Ferri Sesquioxydum*, p. 837). Hence when employed in medicine it must be prepared extemporaneously.

PROPERTIES.—Native protocarbonate of iron is yellow: the primary form of its crystals is the obtuse rhombohedron. Carbonate of iron prepared as above directed is a white precipitate, which by exposure to the air becomes at first greenish, then brown (*sesquioxide*). It is insoluble in water, but dissolves in sulphuric or hydrochloric acid with effervescence. It also readily dissolves in carbonic acid water: the *acidulo-chalybeate waters* are natural solutions of this kind (see pp. 266 and 268).

Characteristics.—It dissolves in diluted sulphuric acid with effervescence. The solution possesses the before-mentioned properties of the ferruginous solutions (see p. 829).

COMPOSITION.—Carbonate of the protoxide of iron is thus composed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Stromeyer.*
Protoxide of Iron	1	36	62	59·6276
Carbonic Acid	1	22	38	38·0352
Carbonate of Iron	1	58	100	97·6628

PHYSIOLOGICAL EFFECTS AND USES.—It is one of the most valuable of the ferruginous compounds, on account of the facility with which it dissolves in the fluids of the stomach, and becomes absorbed. Its local effects are very mild.

Its uses are those of chalybeates in general, and which have been before mentioned.

1. FERRI CARBONAS SACCHARATUM, E. *Saccharine Carbonate of Iron.* (Sulphate of Iron, ℥iv.; Carbonate of Soda, ℥v.; Pure Sugar, ℥ij.; Water, Oiv. Dissolve the sulphate and carbonate each in two pints of the water; add the solutions and mix them; collect the precipitate on a cloth filter, and immediately wash it with cold water, squeeze out as much of the water as possible, and without delay triturate the pulp which remains with the sugar previously in fine powder. Dry the mixture at a temperature not much above 120°.)—Dr. Becker, of Mühlhausen, suggested this compound. His idea was carried out by Klauer[p]; and hence this preparation is known on the continent as Klauer's *Ferrum Carbonicum Saccharatum.* The sugar checks, though it does not completely prevent, the further oxidation of the iron. This preparation is a greenish powder[q], composed of *sesquioxide of iron,*

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[p] *Pharmaceutisches Central-Blatt für* 1836, S. 827; also, *Journ. de Pharmacie,* t. xxiii. p. 86.

[q] For some observations on its chemical properties see a paper by A. Buchner in the *Pharmaceutisches Central-Blatt für* 1837, S. 755.

sugar, and *carbonic acid*, with some *sesquioxide of iron.* Its characters are, according to the Edinburgh College, as follows:—

Colour grayish-green; easily soluble in muriatic acid, with brisk effervescence.

It may be given in doses of from five to ten grains.

2. **MISTURA FERRI COMPOSITA**, L. E. D.; *Compound Mixture of Iron; Griffith's Mixture.* (Myrrh, powdered, ʒij.; Carbonate of Potash, ʒj.; Rose Water, f℥xviij.; Sulphate of Iron, powdered, ℈ijss.; Spirit of Nutmeg, f℥j.; Sugar, ʒij. Rub together the Myrrh with the Spirit of Nutmeg and the Carbonate of Potash; and to these, while rubbing, add first the Rose Water with the Sugar, then the Sulphate of Iron. Put the mixture immediately into a proper glass vessel, and stop it. *L.* The processes of the *Edinburgh* and *Dublin Colleges* are essentially the same.)—This is a professed imitation of Dr. Griffith's celebrated antihectic or tonic mixture[r].

In the preparation of it, double decomposition takes place: by the mutual reaction of carbonate of potash and sulphate of iron we obtain sulphate of potash, which remains in solution, and carbonate of protoxide of iron, which precipitates. To prevent the latter attracting more oxygen, it is to be preserved in a well-stoppered bottle. The quantity of carbonate of potash directed to be used is almost twice as much as is required to decompose the quantity of sulphate of iron ordered to be employed. The excess combines with the myrrh, and forms a kind of saponaceous compound, which assists in suspending the carbonate of iron in the liquid.

When first made, this mixture has a greenish colour, owing to the hydrated ferruginous carbonate; but by exposure to the air it becomes reddish, owing to the absorption of oxygen, by which sesquioxide of iron is formed, and carbonic acid evolves: hence it should only be prepared when required for use.

It is one of the most useful and efficacious ferruginous preparations, and which is owing to its ready solubility, by which it is easily digested and absorbed. Its constitutional effects are analogous to those of the ferruginous compounds in general, and which have been already described. Its tonic and stimulant operation is promoted by the myrrh: the excess of alkaline carbonate must not be forgotten in estimating the sources of activity of this medicine.

It is admissible in most of the cases in which ferruginous remedies are indicated; but it is especially serviceable in anæmia, chlorosis, atonic amenorrhœa, and hysterical affections. It is also employed with benefit in the hectic fever of phthisis and chronic mucous catarrhs. It is contra-indicated in inflammatory conditions of the gastro-intestinal membrane.

The dose of it is one or two fluidounces three or four times a day. Of course acids and acidulous salts, as well as all vegetable astringents which contain gallic or tannic acid, are incompatible with it.

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[r] *Pract. Observations on the Cure of Hectic and Slow Fevers, and the Pulmonary Consumption.* 1776.

3. PILULÆ FERRI COMPOSITÆ, L. D. *Pilulæ Ferri Carbonatis*, E.; *Pilulæ Ferri cum Myrrhâ*; *Compound Pills of Iron*; *Pills of Carbonate of Iron.* (Myrrh, powdered, ʒij.; Carbonate of Soda; Sulphate of Iron; Treacle, of each, ʒj. Rub the myrrh with the carbonate of soda; then having added the sulphate of iron, rub them again; afterwards beat the whole in a vessel previously warmed, until incorporated, *L.*—The *Dublin College* orders, a drachm of Brown Sugar instead of Treacle.—The *Edinburgh College* orders, of Saccharine Carbonate of Iron, *four parts*; Conserve of Red Roses, *one part.* Beat them into a proper mass, to be divided into five-grain pills.)—Prepared according to the London and Dublin Colleges these pills are analogous in composition, effects, and uses, to the preceding preparation. Double decomposition takes place between the two salts employed, and the products are sulphate of soda and carbonate of iron. The carbonate of soda is preferred to the carbonate of potash, on account of the deliquescence of the latter. These pills, like the mixture, should only be made when required for use. The effects and uses of these pills are similar to those of the *Mistura Ferri composita.*—Dose, from grs. x. to grs. xx.

3. SUPERCARBONATED CHALYBEATES.—Carbonate of the protoxide of iron dissolves in water by the aid of carbonic acid. The *Carbonated Chalybeate Mineral Waters* (see p. 266) are solutions of this kind.

Artificial solutions of the carbonated chalybeates are prepared in various ways. A convenient extemporaneous solution is obtained by mixing intimately sulphate of iron and bicarbonate of soda (*sodæ sesquicarbonas*, L.), and dissolving them in a tumblerful of carbonic acid water (*bottled soda water*). One hundred and thirty-nine grains of crystallized sulphate of iron require eighty-three grains of *sodæ sesquicarbonas*, L. to yield fifty-eight grains of carbonate of iron. It is advisable, however, to employ an excess of the sesquicarbonate of soda. If 10 grs. of sulphate of iron, and 10 grs. of the sesquicarbonate of soda *L.* be used, we shall obtain a solution of about 4 grs. of carbonate of iron, 2½ grs. of sulphate of soda, and 5 grs. of sesquicarbonate of soda. The solution should be taken in a state of effervescence.

Another mode of preparing a solution of carbonate of iron is to add bicarbonate of soda to a solution of sulphate of iron acidulated by some acid, as sulphuric, tartaric, or citric acid.

13. POTAS'SÆ FER'RO-TAR'TRAS.—FERRO-TARTRATE OF POTASH.

(Ferri Potassio-Tartras, *L.*—Ferrum Tartarizatum, *E.*—Ferri Tartarum, *D.*)

HISTORY.—This preparation was first described by Angelus Sala at the commencement of the seventeenth century. Mr. R. Phillips[rr] improved its mode of preparation. The late Dr. Birkbeck has described its medical properties[ss]. Besides the above, it has had various other names; such as *Chalybeated Tartar* (*Tartarus chalybeatus* seu *ferratus*), and *Tartrate of Potash and Iron* (*Potassæ et Ferri Tartras*).

[rr] *An Experimental Examination of the last edition of the Pharmacopœia Londinensis.* 1811.

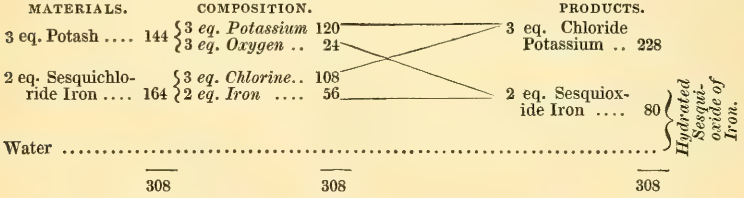
[ss] *Lond. Med. Review*, No. xix. July 1812.

PREPARATION.—Soubeiran[s] directs this compound to be thus prepared: Take of Powdered Bitartrate of Potash, *one part*; Distilled Water, *six parts*; Moist Hydrated Sesquioxide of Iron, *as much as may be sufficient*: digest them, at the temperature of from 120° to 140° F., until the liquor ceases to dissolve a fresh quantity of hydrate; then filter, and evaporate to dryness by a gentle heat.

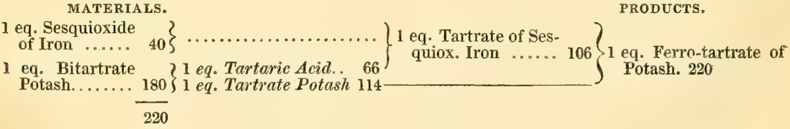
The process of the London College, according to Mr. Phillips[t], is a modification of that of Soubeiran. It is, however, much more complex.

The *London College* orders of Sesquioxide of Iron, ℥iij.; Hydrochloric Acid, Oss.; Solution of Potash, Oivss., or as much as may be sufficient; Bitartrate of Potash, ℥xiss.; Solution of Sesquicarbonate of Ammonia, Oj.,, or as much as may be sufficient; Distilled Water, *Cong.* iij. Mix the sesquioxide of iron with the acid, and digest for two hours in a sand-bath. Add to these two gallons of the water, and set aside for an hour: then pour off the supernatant liquor. The solution of potash being added, wash what is precipitated frequently with water, and while moist boil it with the bitartrate of potash, previously mixed with a gallon of the water. If the liquor should be acid when tried by litmus, pour into it solution of sesquicarbonate of ammonia until it is saturated. Lastly, strain the liquor, and with a gentle heat let it evaporate, so that the salt may remain dry.

The *theory* of this process is as follows:—By the reaction of sesquioxide of iron and hydrochloric acid we obtain water and sesquichloride of iron (see p. 842). On the addition of caustic potash the sesquichloride is decomposed, hydrated sesquioxide of iron is precipitated, and chloride of potassium is left in solution. These changes are illustrated by the following diagram:—



When the hydrated sesquioxide of iron is boiled with bitartrate of potash, one equivalent or 40 parts of the sesquioxide combine with one equivalent or 66 parts of tartaric acid of the bitartrate of potash, and form an equivalent or 106 parts of tartrate of sesquioxide of iron, which combine with an equivalent or 114 parts of tartrate of potash, to form one equivalent or 220 parts of ferrotartrate of potash.


MATERIALS.
PRODUCTS.
1 eq. Sesquioxide of Iron 40
1 eq. Bitartrate Potash........ 180
1 eq. Tartaric Acid.. 66
1 eq. Tartrate Potash 114
1 eq. Tartrate of Sesquiox. Iron 106
1 eq. Ferro-tartrate of Potash. 220
220

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[s] *Nouveau Traité de Pharmacie*, t. ii. p. 447, 2nde éd.
[t] *Translation of the Pharmacopœia.*

The *Edinburgh College* orders of Sulphate of Iron, ℥v.; Bitartrate of Potash, ℥v. and ʒj.; Carbonate of Ammonia in fine powder, a sufficiency. Prepare the Rust of iron from the sulphate as directed under Ferrugo, and without drying. Mix the pulpy mass with four pints of water; add the Bitartrate; boil till the rust of iron is dissolved; let the solution cool; pour off the clear liquid, and add to this the carbonate of ammonia so long as it occasions effervescence. Concentrate the liquid over the vapour bath to the consistence of a thick extract, or till the residuum becomes on cooling a firm solid; which must be preserved in well-closed vessels.

The explanation of the formation of hydrated sesquioxide of iron (here called Rust) has been already explained (see p. 840). The theory of the other part of the process is the same as that of the process of the London Pharmacopœia.

The *Dublin College* orders of Iron, drawn into thin wire, *one part;* Bitartrate of Potash, in very subtile powder, *four parts;* Distilled Water, *eight parts,* or as much as may be sufficient. Let them be mixed, and exposed to the air during fifteen days in a wide vessel. Let the mixture, which is to be occasionally stirred, be kept constantly moist by the daily addition of water, taking care that the iron shall not be entirely covered by the water. Lastly, boil the product in a sufficient quantity of water, and let the filtered liquor evaporate to dryness over a water bath. Let the Tartar of Iron be kept in a well-stopped vessel.

By the united agencies of air and water the iron is converted into the sesquioxide, which combines with the bitartrate of potash to form tartarized iron.

PROPERTIES. — It is an olive-brown inodorous powder, with a styptic inky taste. It reacts on vegetable colours, mildly alkaline. It is slightly deliquescent, probably from the tartrate of potash which it contains. It dissolves in about four times its weight of water, and slightly in alcohol.

Characteristics. — Ferrocyanide of potassium does not occasion any blue colour with it, unless a few drops of acid be added. Potash, soda, and their carbonates, do not decompose it at ordinary temperatures, nor does ammonia or its carbonate even by the aid of heat. Tincture of nutgalls causes a dark-coloured precipitate. Sulphuric, nitric, or hydrochloric acid, throws down the sesquioxide of iron from a solution of this salt; an excess of acid redissolves it: the solution has then a very astringent taste. Tartaric acid causes the formation of crystals of tartar. Heated in a covered crucible, ferrotartrate of potash yields charcoal, carbonate of potash, and protoxide of iron.

COMPOSITION.—The following table exhibits the composition of this salt, according to Soubeiran and Phillips :—

	Phillips.			Soubeiran.	
	Atoms.	*Eq. Wt.*	*Per Cent.*		*Per Cent.*
Tartrate of Sesquioxide of Iron	1	106	48·18	Sesquitartrate of Sesquioxide	45
Tartrate of Potash	1	114	51·82	Tartrate of Potash	55
Ferro-tartrate of Potash	1	220	100·00	„	100

Soubeiran says it contains 13 per cent. of sesquioxide of iron; whereas, according to Mr. Phillips, the quantity is 18·18 per cent.

The ferrotartrate of potash is to be regarded as a double salt, in which tartrate of iron is the acid or electro-negative ingredient, and tartrate of potash the basic or electro-positive constituent. On this view, we comprehend why ferrocyanide of potassium and the alkalis refuse to act on it in the way they do on the ordinary ferruginous salts, until an acid be added. Geiger[u] regards it as a combination of tartrate of iron and ferrate of potash.

PURITY.—In commerce we frequently meet with an imperfectly prepared compound, in which none or only part of the sesquioxide of iron is in chemical combination with bitartrate of potash. In this state it is only partially soluble in water, and the solution strikes a blue colour with the ferrocyanide of potassium, and throws down a reddish brown precipitate with solution of potash. The following are the characters of the properly prepared salt:—

Totally soluble in water: the solution does not change either litmus or turmeric: nor is it rendered blue by ferrocyanide of potassium; nor is any thing precipitated from it by any acid or alkali. The magnet does not act upon it. *Ph. Lond.*

Entirely soluble in cold water: taste feebly chalybeate: the solution is not altered by aqua potassæ, and not precipitated by solution of ferrocyanide of potassium. *Ph. Edinb.*

PHYSIOLOGICAL EFFECTS.—In its effects on the system it agrees, for the most part, with other ferruginous compounds. Its taste, however, is comparatively slight; its astringency is much less than the sulphate or sesquichloride, and consequently its constipating effects are not so obvious; and its stimulating influence over the vascular system is said to be somewhat milder. These peculiarities in its operation are supposed to depend on the tartaric acid and potash with which it is in combination.

USES.—It is not frequently employed, yet it is a very eligible preparation of iron, and may be employed wherever the ferruginous tonics are indicated.

ADMINISTRATION.—The dose of it is from ten grains to half a drachm, in the form of solution or bolus, combined with some aromatic.

14. FER'RI ACE'TAS, *D.*—ACETATE OF IRON.

HISTORY.—A solution of iron in acetic acid has long been known and used in the arts. It constitutes the *Iron Liquor* of the dyer.

PREPARATION.—The *Dublin College* orders it to be prepared as follows:—

Take of Carbonate [Sesquioxide] of Iron, *one part;* Acetic Acid, *six parts.* Digest during three days, and filter.

PROPERTIES.—It is a deep-red liquid, having an acid chalybeate taste. It reddens litmus.

Characteristics.—When heated, it yields acetic acid. Ferrocyanide of potassium strikes a blue colour with it; infusion of galls a purplish black.

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[u] *Handb. d. Pharm.*

Composition.—It consists of the *Acetate of the Protoxide* and *Acetate of the Sesquioxide of Iron.*

The Physiological Effects and Uses are the same as other ferruginous compounds.—The dose is from ten to twenty-five drops, in water.

1. **FERRI ACETATIS TINCTURA**, D. (Acetate of Potash, *two parts;* Sulphate of Iron, *one part;* Rectified Spirit, *twenty-six parts.* Rub together the acetate and sulphate, then dry, and add the spirit. Digest for seven days in a well-stoppered bottle; then pour off the clear liquor, and preserve in a vessel perfectly closed.)—In this process sulphate of potash and acetate of iron are formed: the latter, as well as the excess of the acetate of potash, dissolves in the spirit. It is a claret-coloured tincture. It possesses the usual properties of a ferruginous compound. It is said to be an agreeable chalybeate, and was introduced into the Dublin Pharmacopœia by Dr. Perceval.—The dose is from half a drachm to a drachm.

2. **TINCTURA ACETATIS FERRI CUM ALCOHOLE**, D. (Sulphate of Iron; Acetate of Potash, āā ℥j.; Alcohol, Oij. [*wine measure*]. Triturate together the sulphate and acetate, then dry them, and when cold add the alcohol. Digest in a well-stoppered bottle for twenty-four hours). —The dose is from twenty drops to a drachm.

OTHER FERRUGINOUS COMPOUNDS.

1. **FERRI PERSULPHAS**; *Persulphate of Iron.*—The mode of converting sulphate of the protoxide into sulphate of the sesquioxide of iron has been already pointed out (see p. 840). Persulphate of iron combines with albumen to form a pale yellowish compound[v]; on this property depends its chemical action on the tissues. Dr. Osborne[w] says, Widow Welch's pills are composed of "sulphate of peroxide of iron, with a small quantity of insipid vegetable matter, probably gum, as much as is requisite for adhesion." It is more probable, however, that they are prepared with the common sulphate of the shops, which is a mixture of protosulphate and persulphate of iron.

2. **FERRI PERNITRAS**; *Pernitrate of Iron*—A solution of this salt has been employed as an astringent in diarrhœa[x]. It is prepared by dissolving iron in diluted nitric acid to saturation.

3. **AMMONIÆ FERRO-TARTRAS**; *Ferro-Tartrate of Ammonia; Tartrate of Iron and Ammonia; Aikin's Ammonia-Tartrate of Iron.* This salt was first employed in medicine by Mr. Aikin[y].

It may be prepared by adding caustic ammonia to a solution of tartrate of iron (prepared by digesting together, for two or three days, one part of tartaric acid, dissolved in hot water, with two or three parts of iron filings). The green solution thus obtained is to be evaporated to dryness by a gentle heat[z].

It is in the form of shining brittle fragments of a deep red colour, not very unlike pieces of deep-coloured shell-lac. It is very soluble in water. Its taste is strongly saccharine.

Its general effects are analogous to those of the other ferruginous compounds, except that it has very little if any astringency. Its advantages over other chalybeates are its ready solubility in water, its palatable taste, and the facility with which it may be mixed with various saline substances, without undergoing decomposition. It contains more oxide of iron than the same quantity of sulphate. The dose for an adult is five or six grains in powder, pill, or solution. It may be exhibited in porter without being detected by the taste. It may be added to the compound decoction of aloes without suffering decomposition.

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[v] *Journ. de Chim. Méd.* t. vi. 2de Série, p. 308.

[w] *Lond. Med. Gaz.* March 6, 1840, p. 892.

[x] See Dr. S. W. Williams, in the *Boston (U. S.) Medical and Surgical Journal,* April 7, 1841.

[y] *Lond. Med. Gaz.* vol. viii. p. 438.

[z] Aikin, *op. cit.*

A *Ferro-citrate of Ammonia* (called *Citrate of Iron*) is met with in the shops. Its properties are similar to those of the preceding preparation.

4. **FERRI LACTAS**; *Lactate of Iron.*—This salt occurs in beautiful small, green, acicular crystals. It has been used in medicine[x], though it does not appear to present any advantages over the other preparations of iron.

5. **VINUM FERRI**, Ph. L. 1809; *Wine of Iron.* (Iron Filings, ℥ij.; Wine, [Sherry] Oij. [*wine measure*]. Mix and set the mixture by for a month, occasionally shaking it; then filter it through paper).—The iron is oxidized by the air and water, and the sesquioxide combines with the tartaric acid of the wine. It is properly discarded from the pharmacopœias.—Dose, ʒj. to ʒiv.

ORDER XXVIII.—BINOXIDE OF MANGANESE.

MANGANE'SII BINOX'YDUM.—BINOXIDE OF MANGANESE.

(Manganesii Oxidum, *E.*)

History.—Native binoxide of manganese has been long known and used in the manufacture of glass (*Magnesia Vitriariorum*); but until Kaim, in 1770, succeeded in extracting a peculiar metal from it, it was usually regarded as an ore of iron. It is commonly termed *Native Black* or *Peroxide of Manganese*, or for brevity *Manganese.*

Natural History.—The oxide of manganese used in chemistry and pharmacy is the native anhydrous binoxide, called by mineralogists *Pyrolusite.* It is found in great abundance in Cornwall, Devonshire, Somersetshire, and Aberdeenshire, from whence most of what is met with in commerce in this country is obtained. The principal mines of it are in the neighbourhood of Launceston, Lifton, and Exeter. The Upton Pyne mine, once celebrated for its oxide of manganese, has yielded scarcely any for several years past, if, indeed, it be not completely worked out. Pyrolusite is also found in Saxony, Hungary, France, and other countries of Europe.

Preparation.—Native binoxide of manganese after being raised from the mine is broken into small pieces, about the size of peas, and then washed to separate the earthy impurities. It is afterwards ground in mills to an impalpable powder.

Properties.—This mineral occurs massive, columnar, crystallized, and pulverulent: the form of the crystals is the right rhombic prism. The massive variety has sometimes a metallic lustre, but is generally dull and earthy: its colour is iron black or brownish: it soils the fingers in handling it: its sp. gr. varies from 4·6 to 4·9: it is tasteless, odourless, and insoluble in water: it yields a black powder.

Characteristics.—When heated it yields oxygen gas. Mixed with common salt and sulphuric acid it gives out chlorine. Heated with sulphuric acid it evolves oxygen, and forms a sulphate of the protoxide of manganese. It is infusible before the blow-pipe; dissolves in fused borax with effervescence, and colours the globule of an amethystine colour. If it be digested in hydrochloric acid until chlorine cease to be evolved, and the solution be slightly supersaturated with ammonia, we get rid of the sesquioxide of iron: the filtered liquid throws down a white precipitate with ferrocyanide of potassium.

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[x] *British and Foreign Medical Review*, vol. x. p. 565.

COMPOSITION.—Pure binoxide of manganese has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Forchammer.*	*Berzelius and Arfvedson.*
Manganese	1	28	63·5	63·75	64·02
Oxygen	2	16	36·5	36·25	35·98
Binoxide of Manganese	1	44	100·0	100·00	100·00

PURITY.—The native binoxide is, however, never pure: it usually contains oxide of iron, carbonate of lime, sulphate of baryta, and argillaceous matter. Its purity is judged of by the quantity of oxygen which it is capable of yielding; or of the quantity of chlorine set free when this oxide and hydrochloric acid are allowed to act on each other. The quantity of chlorine set free can be estimated by the quantity of protosulphate of iron which it peroxidizes[q]. The brown varieties are inferior to the black ones.

Muriatic acid aided by heat dissolves it almost entirely, disengaging chlorine: heat disengages oxygen. *Ph. Ed.*

PHYSIOLOGICAL EFFECTS.—The effects of this substance are imperfectly known. Kapp[r] first employed it internally. He regards it as a permanent stimulant, and says it promotes the appetite and digestion. Vogt[s] places it among the tonics, and considers it to be intermediate between iron and lead, but his views are altogether theoretical, as he does not seem to have employed it. Dr. Coupar[t] has described several cases of disease which took place among the men engaged in grinding it at the chemical works of Messrs. Tennant and Co. in Glasgow: from these it appears that, when slowly introduced into the system, it produces paralysis of the motor nerves. The disease commences with symptoms of paraplegia. It differs from the paralysis of lead in not causing colica pictonum or constipation, and from mercury in first affecting the lower extremities, and in not exciting tremors of the affected part. C. G. Gmelin[u] tried the effect of the sulphate of the protoxide of manganese on animals, and found that it caused vomiting, paralysis, without convulsions, and inflammation of the stomach, small intestines, liver, spleen, and heart. Gmelin observes, as remarkable, "the extraordinary secretion of bile produced by it, and which was so considerable that nearly all the intestines were coloured yellow by it, and the large intestines had a wax-yellow colour communicated to them[v]." It deserves notice, in connexion with this effect, that the *sel désopilant* of Rouvière, used as a quack remedy to evacuate bile, contains chloride of manganese[w].

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[q] Graham, *Elements of Chemistry*, p. 536.
[r] *Hufeland's Journ.* Bd. xix. St. 1, S. 176.
[s] *Pharmakodynamik.*
[t] *Brit. Ann. of Med.* Jan. 13, 1837, p. 41.
[u] *Versuche, ü d. Wirkungen*, &c.
[v] *Op. cit.* 90.

Dr. Thomson has seen an ounce of the sulphate swallowed without any effect, except the free action of the bowels[x]. Hünefeld[y] gave to a rabbit nearly two drachms of manganesic acid, in three days, in doses of ten or fifteen grains. The only obvious effect was increased secretion of urine. The animal being killed, the peritoneum and external coat of the colon was found of a greenish colour [protoxide of manganese is green], the muscles were readily lacerated and pale, the liver was inflamed, the bile increased. Wibmer[z] gave six grains daily of the carbonate of the protoxide of manganese to a rabbit during many weeks. No disturbance of function was observed. The animal was killed, but neither in the blood nor the muscles could the least trace of manganese be detected.

USES.—It is rarely employed in medicine. Kapp[a] administered it, as well as the salts of manganese, internally as well as externally in the various forms of syphilis. In herpes, scabies, and the scorbutic diathesis, he used it with benefit. Brera[b] used it in chlorosis, scorbutus, hypochondriasis, hysteria, &c. Otto[c] administered it in cachectic complaints with favourable results. Odier[d] employed it in cardialgia. It has been applied as an absorbent in the treatment of old ulcers, as a depilatory, and as a remedy for skin diseases, especially itch and porrigo[e].

ADMINISTRATION.—Internally it has been given in the form of pills, in doses varying from three grains to a scruple, three or four times in the day. As a local agent it has been used in the form of gargle, composed of two or three drachms of the oxide diffused through five or six ounces of barley water. An ointment, consisting of one or two drachms of oxide to an ounce of lard, has also been used.

In chemistry and pharmacy it is employed in the manufacture of oxygen, chlorine, and iodine. In the arts it is used by the bleacher for the production of chlorine; by the glass-maker to destroy the brown colour communicated to glass by iron; and to give an amethystine tint to plate glass; and by the potter for colouring earthenware.

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[w] *Journ. de Chim. Méd.* v. 534.
[x] Coupar, *op. cit.*
[y] Horn's *Archiv f. Med.* Erf. 1830, quoted by Wibmer, *Wirk. d. Arzn.*
[z] *Op. cit.*
[a] *Op. cit.*
[b] Harless, *Neues Journ. d. Ausl. Med. Lit.* Bd. viii. St. 2, S. 57.
[c] Froriep's *Notizen*, Bd. xii. No. 22, S. 347.
[d] *Handb. d. pr. Arzneiwiss.* quoted by Richter.
[e] Rayer, *Treat. on Skin Diseases*, by Willis, p. 58.

END OF VOL. I.

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